

LIBRARY
OF THE
UNIVERSITY
OF ILLINOIS

570.5

ILL

v.16

BIOLOG

17 1940

Return this book on or before the
Latest Date stamped below. A
charge is made on all overdue
books.

University of Illinois Library

~~MAY 10 1943~~

~~MAR 29 1945~~

~~AUG 2 1949~~

~~JUN 6 1957~~

~~FEB 23 1959~~

~~NOV 1 1967~~

~~OCT 15 1971~~

~~OCT 31 1971~~

~~JUN 28 1976~~

~~DEC 11 1978~~

~~FEB 25 1979~~

~~JUN 05 1981~~

~~FEB 10 1982~~

~~MAY 13 1986~~



Digitized by the Internet Archive
in 2011 with funding from
University of Illinois Urbana-Champaign

ILLINOIS BIOLOGICAL MONOGRAPHS

VOLUME XVI

PUBLISHED BY THE UNIVERSITY OF ILLINOIS

URBANA, ILLINOIS 618

EDITORIAL COMMITTEE

JOHN THEODORE BUCHHOLZ

FRED WILBUR TANNER

HARLEY JONES VAN CLEAVE

70.5
ILL-
v. 16

Biology

TABLE OF CONTENTS

Nos. 1-2. The Turtles of Illinois. By ALVIN R. CAHN.

No. 3. The Phylogeny of the Hemiptera, Based on a Study of the Head Capsule. By CHARLES STOCKMAN SPOONER.

No. 4. A Classification of the Larvae and Puparia of the Syrphidae of Illinois, Exclusive of Aquatic Forms. By ELIZABETH M. HEISS.

ILLINOIS BIOLOGICAL MONOGRAPHS

VOL. XVI

No. 4



PUBLISHED BY THE UNIVERSITY OF ILLINOIS
UNDER THE AUSPICES OF THE GRADUATE SCHOOL
URBANA, ILLINOIS

EDITORIAL COMMITTEE

JOHN THEODORE BUCHHOLZ

FRED WILBUR TANNER

HARLEY JONES VAN CLEAVE

A CLASSIFICATION OF THE LARVAE AND
PUPARIA OF THE SYRPHIDAE OF
ILLINOIS EXCLUSIVE OF
AQUATIC FORMS

WITH SEVENTEEN PLATES

BY
ELIZABETH M. HEISS

CONTRIBUTION FROM THE ENTOMOLOGICAL LABORATORY OF THE
UNIVERSITY OF ILLINOIS
No. 187

THE UNIVERSITY OF ILLINOIS PRESS
URBANA
1938

570.5
ILL
v. 16+

ACKNOWLEDGMENTS

The writer wishes to express her sincere appreciation and thanks to Dr. C. L. Metcalf, of the University of Illinois, under whom this work was done, not only for innumerable kindnesses and helpful criticisms but for an academic association that was of inestimable value and inspiration. To Dr. C. L. Fluke, of the University of Wisconsin, an authority on the Syrphidae, the author is also deeply grateful and greatly indebted for much material aid and a kindly, generous interest in the progress of the work.

The favors of many specialists are acknowledged with thanks: to Dr. H. H. Ross, of the Illinois Natural History Survey, for the determination of the host aphids and the loan of Survey material; to Mr. R. A. Cushman and Mr. A. B. Gahan, of the United States National Museum, Mr. L. H. Weld, of Falls Church, Virginia, and Mr. A. R. Park, of Springfield, Illinois, for determinations of parasites reared from syrphids; to Dr. W. P. Hayes, for the loan of the University of Illinois collection of immature syrphids; to Mr. Randall Latta, of the United States Department of Agriculture at Sumner, Washington, for the gift of bulb fly material; to Miss M. A. Palmer and Mr. M. T. James, of Colorado State College, for taxonomic assistance; and to Dr. O. A. Johannsen for the loan of a translation of Vimmer's paper from the Czechoslovakian.

The writer wishes to thank Mr. A. P. Arnason, of the Dominion Entomological Laboratory, Saskatoon, Saskatchewan, and Mr. B. D. Burks, of the Illinois State Natural History Survey, who have turned over to her valuable specimens or data which have been used in this paper.

CONTENTS

Introduction	9
Historical Account	9
Family Characteristics of Immature Syrphidae	10
Egg	10
Larva	11
Puparium	14
Food Habits and Pupariation	15
Evidence of Generic Relationships Afforded by the Larvae	17
Parasites	18
Other Larvae Resembling Syrphidae	19
Taxonomy	20
Glossary	20
Key to the Known Genera	21
Larvae	21
Puparia	24
Descriptions and Keys to Species	27
Allograpta	27
Sphaerophoria	28
Mesogramma	30
Melanostoma	34
Platychirus	36
Lasiophthicus	38
Eupeodes	40
Syrphus	42
Metasyrphus	49
The <i>emarginatus</i> group ("Metasyrphus")	57
Epistrophe	63
Pipiza	65
Paragus	70

Descriptions and Keys to Species (*continued*).

Didea	72
Baccha	73
Chrysotoxum	75
Xanthogramma	76
Xylota	77
Temnostoma	81
Merodon	83
Eumerus	85
Syritta	89
Brachypalpus	91
Tropidia	94
Brachyopa	95
Volucella	96
Microdon	96
Cerioides	97
Appendix: List of Known Parasites	99
Bibliography	101
Plates	105
Index	140

INTRODUCTION

The trend in recent years towards recognition of the necessity and value of studies in the immature taxonomy of insects has produced a number of useful papers on the classification of immature insects. However, there remains much to be done. During the course of a year's study of immature insects with Dr. William P. Hayes at the University of Illinois, the author was impressed with the need for more compact and comprehensive studies in many orders and the need for pioneer work in other orders where keys, if they exist at all, apply only to relatively small groups of families or genera.

In the Diptera, whose larvae are perhaps the most varied in form and habit of those of any order, the classification of immature Orthorrhapha by J. R. Malloch provides the student of the order with an excellent working tool. In the Cyclorrhapha, however, the student has no aid in many groups at all; the larvae are little known, or described in widely scattered papers.

The writer chose the Syrphidae, although some keys already were available for this family, in part because the members of this family are abundant in the region where this work was carried on and in part because of their interest as a transitional group with variable habits. A few forms, such as the rat-tailed maggot, were described very early in entomological history, and numerous accounts of immature syrphids may be found scattered through the literature up to the present time. It has been the author's purpose to bring together and make available all the additional information from the literature which might extend her own studies and contribute to the knowledge of the immature syrphids of this region. Soon after this study was begun, Dr. O. A. Johannsen of Cornell published his "Aquatic Diptera, Part II" (1935) in which was included the known immature stages of Syrphidae found in water. The aquatic forms have been omitted from the present paper for this reason.

Since our knowledge is still far from complete, and the immature stages of many species and even genera are unknown, the keys which follow must be regarded as tentative. If this study provides a better means of identifying the immature stages than has heretofore been available and brings forth some information on the relationships of the genera within this family, the author will be well repaid.

HISTORICAL ACCOUNT

Only the more important and comprehensive accounts will be considered here. The pioneer work was done by Dr. C. L. Metcalf. Between 1911 and 1913 he published in *The Ohio Naturalist* a series of five articles

giving very complete studies of a number of syrphid life histories. In 1913 these were condensed and combined into one paper containing a key to the then known species, "The Syrphidae of Ohio," published in *The Ohio Biological Survey*. This paper contains the first attempt to classify the immature Syrphidae. In 1916 and 1917, Metcalf published two additional series of detailed studies, "The Syrphidae of Maine" and "The Syrphidae of Maine—Second Report," but only the former contains a key. The excellently illustrated "Contributions to the Biology of North American Diptera" by Charles T. Greene (1917, 1923a) contain two series of descriptions of Syrphidae, most of which are among the rarer species. Jones (1922) described immature forms from Colorado, and Campbell and Davidson (1924) from California, but neither of these accounts is more than a series of descriptions. In 1929, Fluke made an interesting attempt to classify the larvae of this family which attack the pea aphid on the basis of the characters of the posterior respiratory process alone. This key is restricted to a portion of the aphidophagous species which occur in the Illinois region. In 1933, a paper by Vimmer appeared with keys to the larvae and puparia of Czechoslovakian syrphids, but in this case, descriptions are lacking. The keys and descriptions of Johannsen (1935) cover what is known of aquatic syrphids and supplement the paper presented here.

With the exception of Vimmer's paper and some of the descriptions of Greene for species which have not been recorded for Illinois, the above papers have been found very useful in this contribution to the taxonomy of immature Syrphidae.

FAMILY CHARACTERISTICS OF IMMATURE SYRPHIDAE

EGG

The eggs of this family which have been seen by the writer (chiefly those of aphidophagous species and of *Mesogramma polita*, the corn-feeding syrphid fly) have all been very similar. They are about a millimeter long by one-fourth millimeter wide, subcylindrical, tapering slightly at the ends, and slightly curved lengthwise. The micropilar end is somewhat blunter than the opposite pole. The egg is milky white or greyish white and covered with a fine raised reticulation, composed of minute elevations with radiating arms branching out to adjoining elevations. The patterns of the sculpturing vary somewhat in different species.

The eggs of the saprophytic forms, *Tropidia* and *Syritta*, according to Metcalf (1916) and of *Helophilus* according to Jones (1922), are also white and oval, but the sculpturing is described as small polygonal areas, slightly raised, with narrow parallel-sided channels between them, forming a fine dark network over the surface of the egg.

The eggs of aphidophagous species are usually laid singly, among or near aphid colonies on the leaf surface or along the stem of the plant where the aphids are found. In the genera *Melanostoma* and *Platychirus* and in *Mesogramma polita*, a few eggs are laid side by side on the plant in little groups of four or five. *Syritta pipiens* and *Tropidia quadrata* lay eggs in masses of one hundred or more (Metcalf, 1916).

The eggs have not been considered in this classification.

LARVA

The larvae of the family Syrphidae are distinguished from the larvae of all other cyclorrhaphous families by two characters: (1) The two posterior respiratory tubes are always contiguous and more or less completely fused except in first instar larvae and in the single species, to the writer's knowledge, *Mesogramma polita*. (2) Each body segment bears twelve segmental spines in definite positions. The single known exception to this condition is that of the remarkable mollusc-like larva of *Microdon*, in which it is not possible to distinguish any segmentation and in which segmental spines appear to be missing as well. All of the larvae of Syrphidae in the writer's possession which were sufficiently well preserved for dissection, were found to possess a set of extrusible sac-like organs opening into the rectum, which are referred to as the rectal gills. In the aphidophagous species, they are small and remarkably similar, but they are highly developed in the saprophytic forms and most elaborate in those whose habitat is aquatic. Gäbler (1932) has used them as a means of differentiation between species of *Eristalis*. Rectal gills appear to be typical of the Syrphidae, but whether they are present extensively in other families, the writer is unable to say. Alsterberg (1934) has analyzed the respiratory structures of a number of aquatic syrphid larvae and states that the rectal gills are blood gills whose function is to eliminate carbon dioxide.

In the descriptions and keys of the present paper which refer to larvae, only mature or third instar larvae are considered, since the early instars are variable and afford less satisfactory and less constant characters for classification. In the aphidophagous forms, larvae of all ages are frequently found together in the same aphid colony.

The larvae, as Metcalf (1913b) has pointed out, fall into three natural groups: first, the aphidophagous forms, including several phytophagous species; second, the saprophytic forms, including the aquatic and semi-aquatic rat-tailed maggots, which are omitted from this paper, the short-tailed slime dwellers, and the phytophagous bulb flies, *Microdon* and *Eumerus*; and, third, the aberrant *Microdon*, which is a scavenger in the nests of ants.

Aphidophagous Type.—The aphidophagous type is usually an anteri-

only attenuated, twelve-segmented, subcylindrical larva. The cephalopharyngeal skeleton consists of the three typical sclerites of cyclorrhaphous larvae. The vertically-moving mandibular sclerites are supplemented by one or several pairs of small chitinated lateral hooks which work horizontally to seize the prey. Above the mouth opening is a pair of soft, fleshy antennal tubercles, each bearing apically a pair of minute processes.

The segments of the head are retractile, making their number difficult to distinguish. The short, rigid, heavily chitinated, anterior spiracular processes are generally considered by authors to be prothoracic, and the segment on which they are located appears to be the third. Behind this are nine segments exhibiting considerable secondary segmentation. Each segment bears twelve two-segmented, but simple spines, more or less elevated on rounded tubercles. On the anterior segments, they are in a nearly transverse row, but on the main body segments the various pairs occupy successively more posterior annulets, always in a definite position. The six *segmental spines* of each side have been named by Metcalf (1913b), beginning at the mid-dorsal line and progressing outward, as illustrated in Fig. 2: *median*, *dorsal*, *dorso-lateral*, *lateral* and two pairs of ventro-laterals, *posterior ventro-lateral*, and *anterior ventro-lateral*.

The integument is tough, but transparent and delicate in appearance. It is indistinctly divided into segments, each with four or five annulets. On the ventral surface are numerous lump-like expansions, and the whole surface, more or less, is brought into play as a creeping sole, but there are never any proleg-like structures as in the saprophytic forms.

Two anterior respiratory processes and a single posterior respiratory process are usually present. The posterior spiracles in this group are always three pairs of slits borne on the tip of two rigid tubes more or less completely fused into a posterior respiratory process which often protrudes considerably from the surface of the body. The surface on which the spiracles are borne has been designated the *posterior spiracular plate*. In addition to the spiracles, the posterior spiracular plate bears the scar of a former spiracle, a circular, rather weakly chitinated area, the *circular plate*, always located dorsad of the center of the posterior spiracular plate. Median to the circular plate there may be present a spine or ridge, elevated above the surface, the *dorsal spur*, and between the spiracles are, variously, nodules, setae, or frilled lamellae, but, in aphidophagous syrphids, never plumose hairs. These structures are referred to as *interspiracular nodules*, *interspiracular setae*, and *interspiracular lamellae*.

The rectal gills are structures which seem to afford, in different genera, interesting characters. They are rarely found extruded in aphidophagous forms, although the writer has seen some score of larvae of this type with the rectal gills fully everted in preserved larvae. No infallible method has

been devised to cause the living larvae to extrude their gills. These structures, however, can be readily examined *in situ* by simply splitting sagittally with a sharp razor blade a larva which has been killed in hot water and preserved for any length of time in 70 per cent alcohol. The rectum can be laid back from either half to expose the half of the paired gills on that side, directly laterad and caudad to the rectum. In all the aphidophagous genera examined, the gills were, on each side, a pair of simple finger-like processes joined at the base. Internally they terminate in a slender filament; when fully extruded they terminate in a simple closed, rounded end. They are represented *in situ* by Figs. 5, 7, 32, and 52; they are shown extruded in Fig. 48.

Saprophytic Type.—The rat-tailed larva, the short-tailed forms inhabiting filth or rotten wood, the phytophagous bulb flies which are actually immersed in a pocket of slime, the wood-boring form *Temnostoma*, and the scavenger *Volucella* are all modifications of the basic saprophytic type of larva characterized by a few rather constant characters. A *false head* is generally present; it consists of a broad anterior hood-like segment, as broad as or broader than the succeeding segments and separated from them by a slight constriction. The mouth parts are usually reduced and weak with the notable exception of the bulb flies, *Merodon* and *Eumerus*, in which the mandibular sclerites are greatly enlarged. The larvae of this group exhibit the longitudinal ridges on the floor of the pharynx which Keilin (1915) has pointed out as characteristic of saprophytic larvae. The external lateral mouth hooks of the aphidophagous larva are missing in this larva, but around the mouth opening is a pair of soft fleshy flaps. Over the mouth opening and continuous with the esophagus is an area of chitinous bars which appear as light brown striations; this is the *mouth-hood* of Metcalf (1913b).

The body is usually cylindrical and bears ventrally seven pairs of prolegs, each with a crown of recurved, heavy hooklets. In some genera the hooklets are missing (*Eumerus*, *Merodon*); in others, both the hooklets and prolegs (*Temnostoma*) are lacking. The segmental spines of this group may be single (*Temnostoma*, *Merodon*) but are most often double, triple, or multiple. There are frequently from one to four posterior fleshy projections covered with spines.

Probably the most typical feature of this type is the posterior spiracular plate. In the rat-tailed forms it is elevated on a long telescopic tube, rigid only for a short distance at the tip. In the short-tailed saprophytes the process bearing the posterior spiracular plates is rigid throughout its length. The posterior spiracles have elaborately looped, S-shaped or denticulated apertures. The openings in some genera are not confined to three pairs but have become subdivided into as high as twenty-five or thirty pairs of openings in *Temnostoma* and nine pairs in some

species of *Volucella*. The posterior spiracular plates are more completely fused in these forms than in the aphidophagous type and often form one simple oval plate. The circular plates are depressed and located near the center of the posterior spiracular plate. The spiracular plate is usually ornamented with four pairs of plumose hairs which are homologous with the interspiracular nodules.

The rectal gills in this group are often many-branched bilateral structures of a definite number of diverticula in each species (Gäbler, 1932; Alsterberg, 1934).

Microdon Type.—The *Microdon* type is one of the curiosities among dipterous larvae. The body form is strongly convex above, almost hemispherical, smoothly oval in outline from above and perfectly flat below. Prolegs are wanting, and the larvae creep with a wave-like motion of the ventral sole. Around the margin is a fringe of fleshy hair-like processes which Metcalf (1913b) suggests may be the migrated homologues of the segmental spines. No segments of any sort are visible. The tough, horny dorsum is ornamented with a reticulate pattern of ridges, papillae, or setae and is usually divided longitudinally into three sections by shallow grooves.

The anterior spiracular processes appear to be missing. The posterior respiratory process is a rigid, apically bifid structure which is very unusual. The circular plates are located in the median notch between the posterior spiracular plates, if the latter can be said to be present at all. The area enclosing the spiracles is swollen and dark, occupying not only the tip but also a short portion of the sides of the process. A complex system of many-branched lobules is visible in this region, but the actual openings of the spiracles are not apparent.

PUPARIUM

The puparium in the aphidophagous forms is a typical cyclorrhaphous puparium formed by induration of the integument of the third instar larva. The body shortens and rounds up, producing a stream-lined or tear-drop form whose proportions vary characteristically in the different genera. The integumental vestiture and processes of the larva remain on the puparium but are shrivelled and distorted. The anterior respiratory processes of the larva, always small, tend to become almost invisible with the contraction of the integument and are not functional in any case. The posterior respiratory process is morphologically similar but often more highly pigmented than that of the larva. The pupal respiratory horns do not appear externally in the puparia of this type. In *Melanostoma mellinum*, according to Metcalf (1916), they can be seen through the unusually transparent integument, as minute specks on the anterior

dorsum of the puparium. But in the single specimen in the writer's possession, the minute respiratory horns actually protrude through the surface of the integument and are visible in profile as tiny nodules. Emergence from the puparium in all Syrphidae occurs through a circular opening produced when the anterior portion breaks open along certain definite abscission lines. In late puparia, the zones of weakening are so well developed that the cap, or *operculum*, can be readily removed by the touch of a needle. The operculum is convex, circular, and subdivided into a dorsal, crescentic piece and a ventral, scallop shell-shaped piece. These break apart from one another and swing outward like doors to permit emergence and are usually left attached at the upper and lower margins of the opening.

In saprophytic forms the puparium is similarly formed from the indurated, inflated, larval integument, but its shape is more fusiform than that of the puparium of the aphidophagous type and is often angular anteriorly. It bears external pupal respiratory horns which are thrust up from the pupa through the upper or crescentic plate of the operculum, rupturing the integument. These do not appear for some time after pupariation, but their site can always be detected by a pair of swollen pad-like areas on the dorsum, which are obvious not only in the early puparium but even in the mature larva. The pupal respiratory horns bear numerous minute apertures.

In the *Microdon* type the shape of the larva, which is relatively rigid, changes little, but becomes much hardened and horny. Pupal horns similar to those in the saprophytic type sprout from the operculum.

FOOD HABITS AND PUPARIATION

Although this paper is primarily taxonomic, a consideration of the food habits of the larvae should not be disregarded. They often afford indications of the identity of the larva or puparium found. For this reason a detailed account of the known food habits has been given for every species.

An interesting review of the literature on the food habits of the larvae of Syrphidae is given by Metcalf (1913b) in "The Syrphidae of Ohio."

Thirteen of the twenty-five genera discussed in this paper are aphidophagous or feed on related Homoptera. These are included in the first fourteen genera listed; the genus *Mesogramma* which is included in this list is exceptional in that the only species whose habits are definitely known is phytophagous. The predaceous syrphids crawl blindly among their host aphids lashing about with the anterior segments until an aphid is found, when the aphid is punctured by the sharp mouth hooks, raised into the air by all but very young syrphids, and drained of its body juices.

The larvae feed voraciously, one individual consuming as high as 530 aphids during its short larval life according to Curran (1920). Since certain of the aphidophagous species are very abundant, they hold in check many a severe aphid infestation by their ravages in colonies of aphids. Many aphid colonies are entirely wiped out and syrphid larvae are not uncommonly encountered moving along twigs with a looping motion in search of food where no aphids are present. The beneficial effect of the activities of the aphidophagous species of the family probably far outweighs the damage done by the harmful members of the family.

The larvae of the genera *Melanostoma* and *Platychirus* are seldom seen. They feed at night and rest in protected crevices by day, showing strong preference for extremely moist situations. The larvae of the genus *Didea* appear to be confined largely to one-host aphids, and those of *Pipiza* are generally found in colonies of woolly aphids.

The larvae of *Mesogramma polita* feed on the pollen and scarify the tissues of corn. They, too, appear to lie quiescent during the day and feed chiefly at night.

The larvae of the genera *Merodon* and *Eumerus* are the most destructive forms of the family in the United States. They attack healthy bulbs, scraping out the interior of the bulb and causing it to decay and die. They are not common enough in Illinois to be pests of great importance.

The larvae of *Syritta* and *Tropidia* live primarily in manure; those of *Xylota*, *Brachypalpus*, and *Temnostoma* are found in rotting, moist wood. *Xylota*, *Brachyopa*, and *Ceria* are recorded from the sap of tree wounds and putrifying pockets of water in tree cavities.

The larvae of *Volucella* are recorded in this region as scavengers in the nests of *Bombus* where they eat dead and dying pupae. The bizarre mollusc-like larvae of *Microdon* are found in the nests of ants and were shown by Donisthorpe in 1911 to feed on the pellets ejected by the ants from their infrabuccal pockets.

Pupariation occurs in many of the aphidophagous forms on the plant on which its host aphids were found. In many cases, the larva crawls to the ground and there pupariates under trash.

The larvae of *Mesogramma polita* always pupariate on the corn plant.

The larvae of the bulb flies leave the wet interior of the bulb and find a drier place for pupariation. This may be on the foliage of the plant, or may be just below the soil surface.

The saprophytic larvae seek a comparatively dry and protected place, under bark, in the drier parts of manure or rotting wood, usually near the surface.

The larvae of *Volucella* and *Microdon* pupariate usually near the entrance of the nests of their hosts.

EVIDENCE OF GENERIC RELATIONSHIPS AFFORDED
BY THE LARVAE

The arrangement of the genera which is used in this paper does not attempt to show an absolute phylogenetic sequence. The genera have, however, been listed with some regard to bringing together those closely related in form or habit.

Williston stated in his classic "Synopsis of North American Syrphidae" that, "a classification drawn from the earlier [larval] characters can rarely supersede that founded upon the mature ones, though it may materially modify it." On the other hand, it seems possible to the writer, that the greater number and complexity of characters of the adult Syrphidae may sometimes serve to confuse the picture and cause the taxonomist of adult forms only to split groups unjustifiably or to unite forms which merit different generic status. The soundness of adult classification is corroborated and enforced when it is found that a unity exists between the larvae as well as between the adults of a given genus.

The larvae and puparia of the Syrphidae exhibit as much variety of form and life habits, perhaps, as can be found in any one family of the Diptera. Within any one genus, however, with a few exceptions, the species are remarkably uniform, not only in structure, but in life habits.

The close structural relationship of the typically aphidophagous genera and the typically saprophytic genera to one another has been pointed out previously. Within the aphidophagous group is an interesting sub-group. The genera *Sphaerophoria*, *Allograpta*, *Melanostoma*, *Platychirus*, and *Mesogramma* are all smooth, delicate-skinned larvae of closely similar habitus. In addition, their food habits are annectant. *Sphaerophoria* and *Allograpta* are primarily aphidophagous, although Davidson (1922) records that the early stages of *Allograpta obliqua* may live for the first few days on plant food. *Melanostoma* and *Platychirus* larvae are often found in situations where no aphids, or few, are present, and Curran has observed (Davidson, 1922) that the larvae of *Melanostoma obscurum* consumed both aphids and decomposing chick-weed and that they were more successful on the latter diet. From this facultative aphidophagous habit it is but a step to the truly phytophagous habit of *Mesogramma polita*.

The American species of the genus *Metasyrphus* have been separated from *Syrphus* by Dr. C. L. Fluke (1933); the larvae of the two genera are actually very distinct although their life habits are much the same. But in the same genus with the adults of the sub-cylindrical *Metasyrphus wiedemanni* larvae, he placed the adults of the very flattened, fringed larvae of the "*Metasyrphus*" *emarginatus* group and of the less flattened larvae of *Epistrophe*. In a later paper he placed the latter group in the

genus *Epistrophe*. The evidence from the known larvae would seem to show that *Epistrophe* is a unified group quite distinct from *Metasyrphus*, as Fluke has definitely shown in his taxonomic studies of the adults, and that his removal of the larvae of *Metasyrphus* is also correct. The characters of the larvae also indicate that the *emarginatus* group which Dr. Fluke placed with *Metasyrphus* does not belong there. Dr. Fluke has communicated personally to the writer that it was included in this genus with considerable doubt but that the adults are more closely related to *Metasyrphus* than to *Epistrophe*. Furthermore, the species of the *emarginatus* group obviously, on the basis of larval characters, do not belong in the genus *Xanthogramma* in which they are originally described. *Xanthogramma flavipes*, according to Fluke, is the only North American species which comes within Schiner's original characterization and its larva is strikingly different from those of the *emarginatus* group but similar to a Czechoslovakian species of *Xanthogramma*, illustrated by Vimmer (1933). The characters of the larvae thus indicate that in this closely related group of genera, *Syrphus*, *Metasyrphus*, *Epistrophe*, and the *emarginatus* group are each distinct and, in the larvae, well-defined genera.

The adults of the genera *Melanostoma* and *Platychirus* are so closely related that it is sometimes exceedingly difficult to place the females even in the correct genus with any certainty. The same similarity exists between the larvae, but neither Dr. Fluke nor the writer, apparently the only two who have attempted to separate the larvae of these genera, has had sufficient material to say whether they may or may not be indistinguishable. If the larvae, after careful study, were indistinguishable, it would seem that the separation of the two genera may be doubtfully valid.

PARASITES

In the course of rearing materials for this study a number of parasites of Syrphidae were reared as well. A list of the known parasitic Hymenoptera and the syrphids from which they have been reared is appended at the end of this paper. Their significance is not small when it is considered that those which are not hyper-parasites limit the usefulness of beneficial syrphid larvae.

The parasites fall into three hymenopterous families, Ichneumonidae, Chalcididae, and Cynipidae. The ichneumons reared were the following species: *Diplazon laetatorius* (Fab.), a preponderantly numerous species, *Diplazon scutellaris* (Cress.), *Syrphoctonus agilis* (Cress.), *Syrphoctonus pleuralis* (Cress.), and *Zamicrotoridea syrphicola* (Ashm.). The chalcids included four species: *Bothriothorax peculiaris* Howard, *Eupteromalus dubius* (Ashm.), *Pachyneuron allograptae* Ashm., and *Syrphophagus*

smithi Kamal. The cynipids were the species *Callaspidia provancheri* Ashm. and *Aspicera* sp.

Of the ichneumons, the extremely common *Diplazon laetatorius* is probably the most important. As a parasite, it lays its eggs in the larva of the host or in the egg on plants, and the adult female destroys many other eggs of syrphids by feeding on them. Kamal (1926a) describes observing a female *D. laetatorius* drill a hole in an egg with her ovipositor and then suck the contents dry. This predaceous habit has been observed also by the writer. When the egg of the parasite is laid in the egg of the host, the larva does not hatch until after the host larva has hatched. In either case the adult emerges from the host puparium through a ragged hole bitten from the anterior end. One parasite only emerges from each host. The species of *Syrphoctonus*, according to Kamal, oviposit in the larva only.

The chalcids are multiple parasites, and from five to thirty individuals emerge from one host through a small round emergence hole usually at the side and ventrad. The species of the genus *Bothriothorax* emerge from both host larvae and host puparia in which they cause a characteristic lumpy, cobblestone-like deformation of the body surface. The numerous oval swellings of the surface are indications of internal cavities occupied by the developing parasites. According to Kamal, *Pachyneuron allograptae* and the species of *Conostigmus* are pupal parasites, laying their eggs on the surface of freshly formed puparia.

The cynipids emerge from the puparium of the host, one to a host. Which stage of the host is actually attacked is not known to the writer.

A parasitized puparium can be detected within a few hours after pupariation; the integument becomes unusually dark with a brassy or slightly greasy sheen. The puparium often fails to round up properly and is notably more slender than a normal one. If the investigator is still in doubt, it is only necessary to await the normal emergence of the syrphid which takes an average of seven days in the summer. If the fly does not emerge on schedule it is usually parasitized, for the parasites always take longer for their development than the syrphid. The ichneumons emerge in from ten days to two weeks, the chalcids in about the same length of time, and the cynipids take from twenty-four to thirty-nine days for their emergence after the pupation of the host.

OTHER LARVAE RESEMBLING SYRPHIDAE

The collector of syrphid larvae inevitably comes across other aphid predators, some of which resemble Syrphidae to such an extent that they may at first be mistaken for syrphids. In the first instar many species of syrphids have non-contiguous posterior spiracular plates, and since the

predatory dipterous maggots of other families when mature are no larger than first instar syrphids, this confusion is not an unnatural mistake.

Very common among aphids attacking cabbage and kohlrabi is *Aphidoletes meridionalis* Felt, a bright orange or pinkish cecidomyiid maggot which never attains a length of more than 2 mm. Its conspicuous third instar resembles, at first acquaintance, a very young syrphid. The life history and immature stages of *Aphidoletes meridionalis* have been described in detail by Davis (1916).

A predaceous agromyzid larva, *Leucopis americana* Malloch was encountered among colonies of the corn leaf aphid and the leaf-curling aphid of elm, *Georgiaphis ulmi* (Wilson). Malloch (1921) records it from several other aphids, on black locust, spirea, apple, and from *Aphis rumicis* L. It is a broadly wedge-shaped, white or greyish maggot slightly larger than *Aphidoletes*, averaging from 2.5 to 3 mm. in length when mature. Its short posterior respiratory processes diverge in two prominent cornicles from the posterior angles of the wedge-like body.

On the flower heads of *Verbasina*, a coarse fall composite with wing-like ridges along its stem, was found a much larger larva, of 10 to 12 mm., beautifully patterned in tones of green and brown. Its concealing coloration among the folded sepals of the flower head made it very difficult to detect, as is true of many syrphids. The plants were infested with *Macrosiphum ambrosiae* Thomas. The larva, however, is not a syrphid but *Cyaniris ladon* Cramer (= *Cyaniris pseudargiolus* Boisduval and Le Conte). On removal from the plant, although the larva is legless a small black chitinized head is apparent. The family Lycaenidae, to which this species belongs, is known to include several other predaceous species.

TAXONOMY

GLOSSARY

The following list of terms is given to assist the student of Syrphidae in the use of the keys. The definitions given are not intended to be comprehensive but only to clarify the terms as they are used in this paper. In general the writer has attempted as much as possible to avoid technical terminology, but it is necessary to employ expressions which indicate, as nearly as possible, the position and nature of the structure involved. Those concerning the posterior respiratory process are confusing because of their similarity but have been chosen with the intention of indicating, in each case, a distinct structure or part of a structure.

Carina: The ridge on which the posterior spiracles are sometimes elevated, or a dorsal ridge of the puparium.

Circular plate: A relatively weakly chitinized, refractive area on the dorsal inner

sector of the posterior spiracular plate or, in saprophytic forms, a sunken area located at or just above the center of the posterior spiracular plate, the inner stigmatic scar of Snodgrass.

Dorsal spur: A sharply pointed spine or a ridge-like elevation of the posterior spiracular plate dorsad and mesad to the circular plate.

False head: A broad, globose or hood-like anterior segment or segments with a visible constriction behind them.

Integumental vestiture, integumental setae: The numerous, minute spines or hairs which may cover the epidermis, not including the segmental spines.

Interspiracular nodule, interspiracular seta, interspiracular lamella: A rounded or roughened protuberance, hair, or lamella situated on the posterior spiracular plate in the angles formed by the spiracles.

Lateral thorns: Heavily chitinized, prominent, curved hooks on the lateral margins of the dorsum of the false head.

Operculum: The convex cap or anterior end of the puparium which splits off in two pieces when the fly emerges.

Posterior respiratory process: The entire posterior respiratory organ, composed of two more or less completely fused tubes.

Posterior spiracles: The apertures or breathing openings on each posterior spiracular plate; they may be slit-like or elaborately looped and convoluted.

Posterior spiracular plate: The flattened, or slightly rounded tip of each tube which bears the posterior spiracles.

Pupal respiratory horns: Horn-like processes which grow up from the pupa and pierce the upper portion of the operculum in saprophytic forms; they possess numerous respiratory openings.

Rectal gills: Paired, eversible, finger-like sacs which may be extruded from the anal opening.

Segmental spines: Twelve major bristles on each segment, approximately in a transverse row in definite positions; the method of designating these spines is discussed in the section on the larva.

Spiracles I, II, III: The posterior spiracles usually occur in three pairs; the dorsal pair is designated I, the median, II, and the most ventral, III.

KEY TO THE KNOWN GENERA

Larvae

- | | |
|--|---|
| Larvae tapering, elongate, of typical maggot-like form, variously wrinkled but without any distinct fleshy projections other than wrinkles (Figs. 1, 40) | 1 |
| Larvae various, flattened, cylindrical or hemispherical, with or without fleshy projections of the body, but not of typical maggot-like form (Figs. 50, 60, 72, 78, 84, 105) | 9 |
| 1. Smooth or moderately wrinkled, sleek, glistening-skinned, usually unicolorous larvae devoid of any integumental vestiture (Fig. 1) | 2 |
| Noticeably wrinkled larvae, usually with a well developed color pattern of diagonal stripes, often with integumental vestiture (Figs. 25, 29, 40) | 5 |
| 2. Posterior respiratory process, nearly twice or more than twice as long as height at tip; lettuce-green, cigar-shaped larvae (Figs. 3, 8) | 3 |
| Posterior respiratory process almost sessile, variously colored but very transparent larvae, the posterior segments usually conspicuously broader and flatter than the rest (Figs. 10, 12) | 4 |

3. Tips of posterior respiratory process roughened when viewed from above, the spiracles elevated on carinae and separated by spur-like elevations; spiracles I and III parallel or almost opposite one another (Figs. 8, 9).....*Allograpta*
 Tips of posterior respiratory process smooth and rounded when viewed from above; the spiracles not elevated on carinae nor separated by perceptible spur-like elevations; spiracles I and III converging at an angle (Figs. 3, 4).....*Sphaerophoria*
4. Posterior spiracle I conspicuously shorter than II and III and widely separated from II and III (Figs. 12, 14, 17).....*Mesogramma*
 Posterior spiracles all of about equal length and in normal positions (Figs. 20, 21).....*Melanostoma*, *Platychirus*
5. Posterior respiratory process shorter than its height but not sessile; dorsal spur present or absent (Figs. 24, 27, 90)..... 6
 Posterior respiratory process longer than high or equal to height of tube at tip; posterior spiracular plate with well-developed dorsal spur or ridge (Figs. 31, 40, 43)..... 8
6. Sharp dorsal spur on posterior spiracular plate (Figs. 23, 27).....*Eupeodes*
 No sharp dorsal spur on posterior spiracular plate..... 7
7. Posterior spiracular plate slanting obliquely ventro-anteriad, so that only the two upper pairs of spiracles are visible usually; very prominent, large segmental spines on high fleshy tubercles; smaller larvae (10 mm.) (Figs. 85, 87, 88, 89, 90, 93).....*Baccha*
 Posterior spiracular plate normal in position, all spiracles visible at once when viewed from end; larger larvae, 14-16 mm. (Fig. 24)....*Lasiophthicus*
8. Except for inconspicuous segmental spines, no integumental vestiture; posterior spiracular plates smoothly rounded with no high carinae, dorsal spur a blunt ridge; robust, broader larvae (Figs. 29, 31).....*Syrphus*
 Integument covered with small sharp spines; posterior spiracular plates angular, with high carinae; dorsal spur a short sharp spine (Figs. 40, 45).....*Metasyrphus*
9. Larvae with lateral fleshy projections, which may be small and caudal in position (*Merodon* and *Volucella*, in part) (Figs. 60, 69, 78, 109, 113, 117) 10
 Larvae without lateral fleshy projections or, if with a fringe of minute fleshy hairs, hemispherical in shape (Figs. 96, 105, 143)..... 25
10. Numerous lateral fleshy projections around entire body margin (Figs. 50, 60, 78)..... 11
 One or more pairs of lateral fleshy projections on posterior segments only (Figs. 69, 113, 117)..... 17
11. Lateral fleshy projections on sides, but none on dorsum (Figs. 50, 60)..... 12
 Lateral fleshy projections on sides continuous over dorsum in conspicuous pointed processes (Figs. 78, 84)..... 13
12. Body broadly ovate; lateral fleshy serrations flattened, on a single plane, posterior spiracular plates bear rugose interspiracular nodules (Figs. 50, 54).....*"Metasyrphus" emarginatus* group
 Body elongate oblong; lateral fleshy serrations plump, on three slightly different levels, posterior spiracular plates bear short bristles on papillae instead of nodules (Figs. 60, 64).....*Epistrophe*
13. Large larvae (15 mm.), covered with black spinules, posterior spiracular plates almost sessile and ornamented with upright, frilled lamellae (Figs. 83, 84).....*Didea*

- Smaller larvae (6-10 mm.), usually bare or with only pale, microscopic spinules, posterior respiratory process longer and without frilled lamellae (Figs. 79, 140)..... 14
14. Posterior respiratory process more than three times as long as height at tip (Figs. 140, 146)..... 15
- Posterior respiratory process at most three times its height at tip (Figs. 74, 75)..... 16
15. Main body segments with three dorsal transverse rows of small, fleshy, bristle-like projections in addition to eight or ten larger dorsal tubercles bearing triple, segmental bristles; posterior respiratory process four times as long as wide (Fig. 140).....*Brachyopa*
- No small fleshy bristle-like projections on dorsum, main body segments bearing sixteen tubercles; posterior respiratory process six times as long as wide (Fig. 146).....*Cerioides signifera*
16. Cylindrical larvae with high transverse rows of rounded tubercles bearing large spines; posterior respiratory process without dorsal spur; integument covered with very short, fine setae (Figs. 85, 87, 88).....*Baccha*
- Broad, slightly flattened larvae without prominent rounded tubercles, but with prominent pointed processes; posterior respiratory process with dorsal spur; integument papillose; larvae about 7 mm. long (Figs. 75, 78, 79).....*Paragus*
17. Posterior fleshy projections three pairs of long tapering tentacle-like structures, at least three or four times the length of the posterior respiratory process (Fig. 142).....*Volucella* (in part)
- Posterior fleshy projections subequal or but slightly longer than the posterior respiratory process..... 18
18. No distinguishable false head; no ventral prolegs bearing hooklets, posterior fleshy projections very small (Figs. 69, 109, 113)..... 19
- A false head present; ventral prolegs, **each bearing a crown of hooklets** (Figs. 103, 134)..... 21
19. Posterior respiratory process shorter than wide, large larvae (13-15 mm.) with one pair of very small fleshy lateral projections just ventral to the posterior respiratory process (Fig. 109).....*Merodon*
- Posterior respiratory process subequal to or longer than wide (Figs. 78, 79) 20
20. Posterior spiracles simple, straight slits on high carinae, separated by strong, simple interspiracular bristles (Fig. 70).....*Pipiza*
- Posterior spiracles contorted, not raised from the surface, each posterior spiracular plate with four groups of palmate hairs (Fig. 122).....*Eumerus*
21. No stout hooks on false head (Fig. 117)..... 22
- One or more pairs of stout polished hooks on false head (Figs. 103, 134, 136) 23
22. Small larvae, under 10 mm.....*Syritta*
- Large larvae, 20 mm.....*Volucella* (in part)
23. A single pair of large lateral hooks on false head and numerous lesser hooklets (Fig. 130).....*Brachypalpus frontosus*
- Two pairs of large lateral hooks on false head and numerous lesser hooklets.....24
24. The two large lateral hooks of each side united at base (Figs. 99, 100, 103).....*Xylota*

- The two large lateral hooks of each side separated by more than the length of one of them (Fig. 138).....*Tropidia*
- The two large lateral hooks on the same basal plate and separated by less than their diameter (Fig. 131).....*Brachypalpus rileyi*
25. Larvae hemispherical, mollusc-like, usually with a fringe of hairs around the margin (Fig. 143).....*Microdon*
- Larvae cylindrical (Figs. 94, 96, 105)..... 26
26. Larvae with two heavy-toothed thoracic rakes anteriorly; posterior spiracular plate ornamented with marginal teeth and feathery palmate hairs (Figs. 105, 107).....*Temnostoma*
- Larvae with no thoracic rakes, posterior spiracular plate smoothly rounded and without ornamentation (Figs. 94, 96)..... 27
27. Larva with posterior spiracular tubes united at tip into a smooth oval plate; spiracles without carinae and elaborately contorted in four or five distinct loops; interspiracular nodules extremely minute (Fig. 97).....*Xanthogramma flavipes*
- Larva with posterior spiracular tubes united at tip in crudely 8-shaped outline; slightly sinuous spiracles on prominent carinae; interspiracular nodules large, raised, wedge-shaped areas (Fig. 95).....*Chrystoxum pubescens*

Puparia

- Puparium with no external evidence of pupal respiratory horns on upper plate of operculum; posterior spiracles of each side three straight simple slits except in *Xanthogramma flavipes* and *Metasyrphus nitens* (Figs. 18, 28, 37, 42, 97)..... 1
- Puparium with either pupal respiratory horns or with two pad-like swellings on the upper plate of the operculum; the small persisting anterior respiratory process of the larval stage is found at the ventral anterior margin of the operculum and should not be mistaken for the pupal respiratory horns; posterior spiracles elaborately looped or denticulate slits, or foliate, except in *Melanostoma*; sometimes more than three (Figs. 108, 111, 112, 129, 141, 145)..... 17
1. Posterior spiracles elaborately contorted (Figs. 42, 97)..... 2
- Posterior spiracles three pairs of simple slits, more or less straight (Figs. 6, 45, 83)..... 3
2. Tip of posterior respiratory process completely fused into one oval spiracular plate, spiracles not raised above the surface, body of puparium a short cylinder (Fig. 97).....*Xanthogramma flavipes*
- Tip of posterior respiratory process separated by a median incision into two spiracular plates, spiracles raised on carinae, body of puparium of typical tear-drop shape (Fig. 42).....*Metasyrphus nitens*
3. Posterior spiracular plates bearing simple, sometimes small, bristles between the spiracles; usually narrow, elongate puparia with roughly corrugated margins (Figs. 65, 67, 68, 71)..... 4
- Posterior spiracular plates bearing interspiracular nodules or lamellae, or apparently no interspiracular structures, but never bristles (Fig. 47).... 5
4. Puparium bulbous anteriorly and dorso-ventrally, flattened posteriorly, narrow, lateral margins irregularly corrugated, often marked with black; interspiracular bristles weak (Figs. 64, 65, 68).....*Epistrophe*

- Puparium convex but not strongly bulbous anteriorly, usually roughened, rugose posteriorly; interspiracular bristles strong (Figs. 67, 70)....*Pipiza*
5. Puparium with shrivelled tags of larval fleshy projections, especially on the posterior segments or marked spike-like projections (Figs. 51, 77, 86, 91). 6
Puparium curving cleanly down to posterior respiratory process without any obvious tags, though sometimes strongly wrinkled in the posterior region (Figs. 16, 28, 37)..... 9
6. Puparium dorso-ventrally flattened on posterior third, strongly arched ventrally, with fleshy tags around entire margin, usually distinctly marked with black (Fig. 51)....."*Metasyrphus*" *emarginatus* group
Puparium compact or slender but not distinctly flattened posteriorly; fleshy tags over entire back as well as around margins (Figs. 77, 86)..... 7
7. Puparium large (10 mm.), golden brown, covered with black bristles, spotted with four longitudinal rows of black, spined papillae; posterior spiracular plates with frilled interspiracular lamellae (Fig. 83).....*Didea*
Puparium small (5-6 mm.), shrivelled spines usually unicolorous with rest of integument, no frilled interspiracular lamellae (Fig. 77)..... 8
8. Posterior respiratory process approximately shorter than high, no dorsal spur on posterior spiracular plate (Figs. 88, 93).....*Baccha*
Posterior respiratory process longer than high, well developed; sharp dorsal spur on posterior spiracular plate; very small, plumply rounded puparia (Figs. 74, 77).....*Paragus*
9. Slender, smooth, clavate puparia, green, straw-colored or light brown but often transparent, revealing through the integument in the late stages the adult abdominal pattern; the anal segment usually broadened into a flat sole; dorsal spur absent; posterior spiracles usually in a dark, roughly triangular field, or heavily outlined in black (Figs. 9, 17, 21)..... 10
Roundedly inflated, rougher puparia, usually strongly wrinkled about the posterior segments; dorsal spur present except in *Lasiophthicus*; posterior spiracles not in a dark triangular field (Figs. 28, 37)..... 13
10. Posterior respiratory process nearly twice as long as height at tip (Fig. 8) 11
Posterior respiratory process almost sessile (Fig. 16)..... 12
11. Tip of posterior respiratory process roughened when viewed from above; posterior spiracles elevated on carinae and separated by spur-like elevations, spiracles I and III parallel or almost opposite one another (Figs. 8, 9).....*Allograpta*
Tip of posterior spiracular process smooth and rounded when viewed from above, spiracles not elevated on carinae nor separated by perceptible spur-like elevations, spiracles I and III converging at an angle (Figs. 3, 4, 6)..... *Sphaerophoria*
12. Posterior spiracle I conspicuously shorter than II and III and widely separated from them (Fig. 12).....*Mesogramma*
Posterior spiracles all of about equal length and in normal positions (Fig. 20).....*Platychirus*
13. No dorsal spur on the posterior spiracular plate, large robust puparia (7-9 mm.) with the posterior end characteristically turned down below the ventral surface (Fig. 28).....*Lasiophthicus*
A dorsal spur present on the posterior spiracular plate, puparia usually smaller than above, some quite robust, but posterior end usually not turned down below the ventral surface (except *Eupeodes*) (Fig. 37).... 14

14. Posterior respiratory process shorter than its height, posterior spiracles II and III nearly parallel to the median axis of the larva and all three approximately parallel to one another (Figs. 23, 27).....*Eupeodes*
 Posterior respiratory process as long as or longer than its height, posterior spiracles II and III rarely nearly parallel to the median axis of the larva, but when this occurs, spiracle I is always distinctly convergent with II and III (Figs. 36, 45)..... 15
15. No integumental vestiture, posterior spiracular plates smoothly rounded with moderate or no carinae; plump, inflated puparia (Figs. 33, 36, 94, 95).... 16
 Integument covered with spinules, posterior spiracular plates angular with high carinae, dorsal spur a sharp spine; longer, oblong puparia (Figs. 40, 43).....*Metasyrphus*
16. Dorsal spur a blunt ridge; interspiracular nodules usually rounded or oval projections (Fig. 36).....*Syrphus*
 Dorsal spur a tube-like structure surrounding the circular plate; interspiracular nodules granular raised wedges (Fig. 95)....*Chrysotoxum pubescens*
17. Puparium slender, clavate, smooth and devoid of vestiture; pupal respiratory horns minute, posterior spiracles straight and simple (Fig. 19)..*Melanostoma*
 Puparium not as above..... 18
18. Puparium with flat, nearly circular operculum and two heavy-toothed thoracic rakes at ventral edge of operculum (Fig. 108).....*Temnostoma*
 Puparium with convex operculum and no thoracic rakes (Figs. 111, 137, 141)..... 19
19. Puparium with one or more stout polished curved hooks on each side just below the ventral edge of the operculum (Figs. 99, 101)..... 20
 Puparium with no stout curved hooks at the ventral edge of the operculum (Figs. 123, 126)..... 22
20. A single stout hook on each side (Fig. 130).....*Brachypalpus frontosus*
 Two stout hooks on each side (Figs. 99, 131, 141)..... 21
21. The two stout hooks of each side joined at base (Figs. 99, 100).....*Xylota*
 The two stout hooks of each side separated by more than the length of one (Fig. 141).....*Tropidia*
 The two stout hooks on the same basal plate and separated by less than their diameter (Fig. 131).....*Brachypalpus rileyi*
22. Many shrivelled projections of tubercles over whole body, some long and hair-like (Figs. 77, 140, 146)..... 23
 Shrivelled fleshy projections only at posterior end or ventral margin of body (Figs. 111, 123, 143)..... 24
23. Posterior respiratory process at least six times as long as high at tip (Fig. 146).....*Cerioides signifera*
 Posterior respiratory process not more than four times as long as high at tip (Fig. 140).....*Brachyopa*
24. Puparium hemispherical, or oval and strongly arched above, flat below, with a fringe around the ventral margin (Fig. 143).....*Microdon*
 Puparium cylindrical or fusiform (Figs. 96, 98, 111, 123)..... 25
25. Puparium large (13 mm.), with posterior respiratory process short, broad and stump-like, about as long as wide except in *Volucella nigra* (Figs. 111, 142)..... 26
 Puparium small, not over 8 mm. long, with posterior respiratory process considerably longer than broad (Figs. 123, 126)..... 27

26. A single pair of short papilla-like fleshy projections near the posterior respiratory process; the two posterior spiracular plates fused into one transverse oval plate (Figs. 111, 112).....*Merodon*
 Three pairs of fleshy projections near the posterior respiratory process, in some species very short; in others longer than the posterior respiratory process; the two posterior spiracular plates usually more or less divided by dorsal and ventral grooves (Fig. 142).....*Volucella*
27. Pupal thoracic horn capitate, three pairs of minute posterior fleshy projections (Figs. 121, 126).....*Syritta*
 Pupal thoracic horn tapering, four pairs of minute posterior fleshy projections (Figs. 120, 123).....*Eumerus*

DESCRIPTIONS AND KEYS TO SPECIES

In general, the descriptions of larvae apply to mature or third instar larvae and to living, not preserved colors.

ALLOGRAPTA Osten Sacken

To the genus *Allograpta* and its closest relative, *Sphaerophoria*, belong two of the most common and most important of aphid predators, *Allograpta obliqua* Say and *Sphaerophoria cylindrica* Say. The larvae of both are so similar in general appearance and habits that it is difficult to distinguish even the genus without careful inspection. Both occur abundantly throughout the aphid season and may be found among aphids of almost any species.

Allograpta obliqua Say

The larva and puparium have been fully described and figured by Metcalf (1912a, 1913b, 1916), by Jones (1922), by Campbell and Davidson (1924), and by Fluke (1929), as well as by other earlier workers in a more general fashion.

Description of the Larva.—Length, 9-11 mm., width, 2.5 mm., height, 2.5 mm. The larva is smooth-skinned, cylindrical, and leaf-green with two slender longitudinal stripes of pale green or white close to the mid-line on either side of the dorsal blood vessel. The segmental spines are pale and inconspicuous. There is no integumental vestiture; the larva is transversely wrinkled, but the ridges between the wrinkles are not prominent and, to the naked eye, it appears smooth and glossy. The posterior respiratory process is longer than the combined width of the tubes and is pale strawy tan, but the carinae may be outlined in deep brown or black. A simple two-branched pair of rectal gills sometimes protrudes from anal opening.

Recognition Characters.—1. Tip of the posterior respiratory process

in profile irregular, posterior spiracles raised on carinae and large, protruding interspiracular nodules (Fig. 8). 2. Posterior spiracles I and III nearly in one line drawn through them diagonally across the plate (Fig. 9). 3. Posterior respiratory process at least 0.5 mm. long, and the two component tubes divergent at the tip. 4. The tubes of the posterior respiratory process divergent at their tip (Fig. 8).

Puparium.—Length, 5.5 mm., width, 2.5 mm., height, 2.3 mm. The puparium of *Allograpta obliqua* has an elongate tear-drop shape, somewhat cylindrical medially. The surface becomes inflated and loses all trace of wrinkles. Clear light green at first, it usually changes to a clear rich brown. Some puparia remain green throughout the puparial period. Late in the puparial period, the reddish eyes and dark diagonal abdominal stripes of the imago can sometimes be readily seen through the transparent integument. The characteristics of the posterior respiratory process are the same as those of the larva.

Food Habits.—The larvae of this species have been taken among colonies of the following aphids: *Aphis gossypii* Glover on muskmelons and cucumbers, *Rhopalosiphum pseudo-brassicae* (Davis) on turnips, *Amphorophora cosmopolitana* Mason on wild lettuce, *Myzocallis alhambra* Davidson on burr and white oak, *Macrosiphum sanborni* Gillette on chrysanthemum, *Aphis viburnicola* Gillette on viburnum, *Aphis rumicis* Linn. on curly dock, *Aphis oestlundii* Gillette on evening primrose and *Myzus persicae* (Sulzer) and *Brevicoryne brassicae* (Linn.) on cabbage, kohlrabi, and broccoli. Curran (1920) lists in addition *Aphis pomi* DeGeer, the green apple aphid, *Aphis cardui* Linn., the thistle aphid, and *Myzus cerasi* (Fabr.), the black cherry aphid.

SPHAEROPHORIA St. Fargeau and Serville

The larvae of this genus, like those of *Allograpta*, are common and valuable enemies of aphids. They exceed in numbers any other species of syrphid in this region, except *Mesogramma marginata*, whose larval food habits are unknown. Since, according to Curran (1920), the larvae of this species also consume more aphids per individual than those of any other species, this species may be said to be the most beneficial syrphid in Illinois.

KEY TO SPECIES OF SPHAEROPHORIA

- Smaller larvae, averaging 10 mm., posterior respiratory process 0.5 mm. in length, the tip fairly smooth with small interspiracular nodules....*cyndrica*
 Larger larvae, averaging 11 mm., posterior respiratory process much shorter than that of *cyndrica*, 0.25 mm. to 0.45 mm. and with a very smooth tip....*robusta*

Sphaerophoria cylindrica (Say)

The larva and puparium of this species are described in detail and figured by Metcalf in 1912. In 1913 and 1916, briefer descriptions are given by the same author. The posterior spiracular plate is figured by Fluke (1929), who reports this species less common in Wisconsin than *Sphaerophoria robusta* (*scripta*).

Description of the Larva (Fig. 1).—Length, 10 mm., width, 2.5 mm., height, 2.5 mm. It is a smooth, green larva of the same size, color, and habits as *Allograpta* and can be distinguished from it only by the characteristics of the posterior respiratory process given below.

Recognition Characters.—1. Tip of the posterior respiratory process in profile smoothly rounded and shallowly notched; posterior spiracles not raised on carinae, interspiracular nodules inconspicuous (Figs. 3, 4). 2. Posterior spiracles I and III converge distinctly toward its center, forming an obtuse angle (Fig. 4). 3. Posterior respiratory process about 0.5 mm. 4. Tubes of posterior respiratory process vary from not at all divergent at the tip to slightly divergent at tip (Fig. 3).

Puparium.—Length, 5.5 mm., width, 2.5 mm., height, 2.3 mm. As in *Allograpta*, the puparium is slender and elongate. It often remains green throughout the puparial period, but may turn reddish brown. Late in the puparial period, the adult pattern is visible through the integument. The characters of the posterior respiratory process are the same as those of the larva.

Food Habits.—The larvae of this species have been taken among colonies of the following aphids: *Aphis gossypii* on muskmelons and cucumbers, *Aphis nerii* on wild lettuce, *Rhopalosiphum pseudo-brassicae* on turnips, *Amphorophora cosmopolitana* on wild lettuce, *Myzocallis alhambra* on burr and white oak, *Macrosiphum sanborni* on chrysanthemum, *Aphis viburnicola* on viburnum, *Aphis rumicis* on curly dock, *Aphis oestlundii* on evening primrose, and *Myzus persicae* and *Brevicoryne brassicae* on cabbage, kohlrabi, and broccoli. Curran (1920) lists in addition *Aphis pomi*, the green apple aphid, *Aphis cardui*, the thistle aphid, and *Myzus cerasi*, the black cherry aphid.

Sphaerophoria robusta Curran (*Sphaerophoria scripta* Fluke)

This is the *Sphaerophoria scripta* of Fluke and has been reported by him (1929) as being much more common in Wisconsin than *Sphaerophoria cylindrica*. The adults have been taken in the Urbana region rarely, but the larvae have not been seen by the writer. The larvae are slightly larger than those of *cylindrica*, averaging 11 mm.

Fluke distinguishes the larva as follows: 1. Tip of posterior respiratory process in profile, smooth. He mentions that the interspiracular nodules are even less conspicuous than in *Sphaerophoria cylindrica* (Fig. 6). 2. Posterior respiratory process is much shorter than that of *cylindrica*, from .25 mm. to .45 mm., a difference which can be distinguished by the naked eye.

Food Habits.—Fluke (1929) reared this species from *Macrosiphum (Illinoia) pisi* (Kalt.) the pea aphid.

Sphaerophoria menthastris Linnaeus

The writer has not seen any larvae of this species, but a series of puparia loaned by Dr. C. L. Fluke show, in the majority of puparia, but not all, a distinct black cross-banding on the anterior end, a feature not known to occur on the puparium of any other species of this group. Judging from other banded puparia, indications of these bands are probably not present in the larva. The posterior respiratory process, in the absence of sufficient material, cannot be distinguished from that of *robusta*.

MESOGRAMMA LOEW

The larvae of the genus *Mesogramma*, as far as they have been observed, are delicate, glossy-skinned larvae which are nearly cylindrical in the mid-region, tapering anteriorly, and blunt, flattened, and emarginate at the posterior end. The integument is so transparent that the tracheal tubes and most of the internal organs are plainly visible. The posterior respiratory process is very short, and the two lowest spiracles have migrated down to the extreme ventral edge of the spiracular plate.

The most interesting single fact about this genus is the unusual food habits of the larvae. Although *Mesogramma* is not the only phytophagous syrphid (*Merodon* and *Eumerus*, the bulb flies, and *Chilosia*, recorded from living wood, are both phytophagous and saprophagous), it is one of the very few phytophagous larvae of the typically slender, maggot-like aphidophagous type and probably was originally of this habit. *Mesogramma polita* Say is the "corn-feeding *Syrphus* fly" described nearly fifty years ago by Riley and Howard.

A few specimens of the other known larvae of this genus, *Mesogramma marginata* Say, were reared by Fluke (1929). In spite of the fact that this is an exceedingly common species, the adults occurring by the hundreds in the summer time in open grassy places, the normal food habit of the larva is still an uncertainty. Fluke succeeded in rearing three adults from eggs laid on pea vines. The larvae were three-fourths grown before they were observed to attack a pea aphid and some developed for three days (about half the normal larval life) in cages where

no pollen or aphids were present at all. Fluke is of the opinion that they fed on the bloom of the pea leaves. Folsom (1909) gives both *Mesogramma polita* and *marginata* as aphidophagous. This was undoubtedly their primitive habit and may still be, in part, that of *marginata*, but Folsom's observations seem to be based largely on inference.

In addition to *Mesogramma polita* and *marginata*, there is a third abundant species in the Illinois region, *geminata*, the adult of which seems to prefer the open sunny places of woods and orchards. The habits of its larva are unknown, although Fluke (1929) took two larvae from alfalfa heavily infested with *Macrosiphum pisi*, but they were not separated out until they emerged as adults. Folsom (1922) lists the species as a predator. It is possible that this species may attack a root aphid in the situations where it is most abundant or may be an internal feeder in plants and has thus escaped observation.

KEY TO SPECIES OF MESOGRAMMA

Larger species, 8 mm. or more; posterior spiracular plates completely separated. *polita*
 Smaller species, 4 to 6 mm.; posterior spiracular plates fused. *marginata* or *geminata*

Mesogramma polita Say

The stages of *Mesogramma polita* were described by Riley and Howard (1888). Their figures, which show the general appearance of the larva, puparium, and adult, have been repeated in many publications since. Sanderson (1900) described the larva, puparium, and imago more completely and illustrated them with actual photographs. Metcalf (1913b) pictures the posterior respiratory process of the puparium and the outline of the puparium but does not give a new description. Richardson (1915) gives no figures but an excellent biological account and a complete review of the literature.

Description of the Larva (Fig. 10).—The mature larva is 9-12 mm. long, 2 mm. wide, and 2 mm. high. It is almost cylindrical in the mid-region but tapers cephalad and ends caudally in a blunt, flattened, emarginate anal segment. Each true segment is divided into 4 or 5 subequal annulations, which gives the maggot apparently 40 regular earthworm-like rings. The integument is finely papillose and so translucent that many internal structures are readily visible through it.

The color of the larva varies with different ages and individuals. All first instar larvae are clear pollen-yellow without markings, except where the visceral contents show as a brownish mass. Second instar larvae (Fig. 11) are translucent yellow with two bright rose (often purple) stripes, immediately on either side of the dorsal blood vessel, which

pulsate with the contractions of the heart. The third instar larvae (Fig. 10) are colorless, pale straw-yellow or translucent pale-green with much softer rose or rosy-tan dorsal stripes or, more rarely, dorsal stripes completely lacking.

The anterior spiracles are small brown knobs on the second visible anterior segment. From these the main tracheal trunks run back half-way down the sides as slightly undulating silver tubes, clearly seen through the integument, and end in the posterior respiratory processes. In the anterior third, under the rose stripes, is a large, shining white fat-body.

The posterior respiratory process is sessile or nearly so, and it is unique among the syrphid larvae which the writer has examined in having the spiracular plates completely separated from one another (Figs. 10, 12). They appear as two light brown spots on the upper surface of the flattened, emarginate anal segment. The arrangement of the spiracles is striking; the upper spiracle is only half as long as the others and isolated by more than twice its length from the other two. The latter are crowded down to the ventral edge but not reduced in size. Rectal gills appear to be absent.

Puparium (Figs. 13, 16, 18).—The puparium is 7-8 mm. long, 2.4 mm. wide at the widest point, and 2 mm. high. It is club-shaped, rounded anteriorly, and tapers gradually to the anal segment, which is broader and flatter than that of the larva. The regular annulations of the larva have disappeared, and a carina is present immediately anterior to the posterior spiracles. The puparium is at first lucid yellow or greenish and retains the rose-colored stripes of the larva; it then changes to a clear opaque tan, variously pencilled with dark lines, which have no relation, apparently, to the color markings of the larva. When fully marked there is : (1) a median dorsal longitudinal line which may extend from the apex of the puparium to the posterior respiratory process, (2) a well defined longitudinal lateral line halfway down each side for about three-fourths the total body length, (3) a broken, undulating, sub-dorsal line on each side, midway between the last two, and (4) a sub-lateral, broken line on each side below the lateral line. The presence of the lateral lines alone are the commonest condition, but all may be absent.

The posterior processes differ from those of the larva in that they are more or less united by a brownish hardening of the integument between them, and the spiracles are heavily ringed with black.

Food Habits.—The first instar larvae were found in quiescent masses of a hundred or more lying closely packed and parallel to one another under the upper leaf sheaths of sweet corn. On being disturbed, they become very active, moving rapidly about with a looping motion. When at

rest, they seek the moist situations about the plant, probably because of their delicate skins. At this stage they are engorged with yellow pollen and are rich yellow. In the second instar they are exactly the same size and of much the same shape as a single corn anther; the groove of the anther is mimicked by the double dorsal stripe. Thus, when seen out on the leaf, lying quiet, they resemble a fallen anther among the pollen on the leaf surface. They are scattered farther down the stalk than the first instar and probably feed on juices of the plant as well as pollen.

Adult larvae were observed later beneath every leaf sheath from the top to the base of the corn stalk, in small groups of three or four, scraping away industriously at the succulent tissues of the leaf sheath and leaving wet patches of broken cells. That they also feed on pollen is shown by golden yellow, or brownish, visceral contents, but some show only clear translucent bodies, indicating that they feed on exuding sap alone. The mature larvae, with their soft green or straw-colored bodies and purplish dorsal lines, mimic the purple-veined glumes of the corn tassel. Some are found here as well as under the leaf sheaths and on the blades. Their habit of pupariating head downward among the florets of the tassel and their shape and coloration makes them almost indistinguishable from the true florets. Under the leaf sheaths and in the crevices of the ear husks they also pupariate head downward, often in such pools of sap and dew that only the posterior spiracles, now uppermost, protrude from the liquid.

Mesogramma marginata Say

The only available description of this species is given by Fluke (1929), who succeeded in rearing it from eggs in the laboratory. He figures the puparium and the posterior spiracular plates.

Description of the Larva (Fig. 14).—Fluke (1929) describes the larva as follows: "4 to 4.5 mm. long, 1 mm. wide. Body light greenish yellow. The only dark areas are where the viscera show through. Integument transparent, very slightly papillose. Segmental spines very short and light in color; no integumental vestiture.

"The posterior respiratory organ situated on a papillose base which is as high as the appendage is long. The chitinous ring is not very strong and surrounds the entire organ with gentle indentation curves both dorsal and ventral. In the evolutionary development of this species, spiracles II and III have migrated so that II now occupies the position of III. This also means that the inner or mesal ends of the spiracle were once the outer or distal ends."

Puparium (Fig. 15).—This description is also quoted from Fluke (1929).

"Length 5.2 mm., width 1.5 mm., widest at the front one-third; evenly

rounded anteriorly, tapering gradually to rear. Ventral line almost straight. Two prominent irregular, curved dark lines along the sides, the more dorsal one running from near the front end to within 1 mm. of the rear. Lower line a little more than half as long as the pupa."

Food Habits.—Not known.

Mesogramma geminata Say

The larva of this species is unknown, but Dr. C. L. Fluke has kindly loaned a puparium from which the drawing of the posterior spiracles and the following description are made:

Puparium.—Length, 7 mm., width, 2 mm., height, 2 mm.; broad and evenly rounded at anterior end and tapering evenly toward the rear. The color is light golden-brown. Two dark lines are present along the sides in the same position as those in *marginata* and of about the same extent. The posterior spiracular plates (Fig. 17) are contiguous in the puparium, and from their structure were evidently so in the larva as well. The spiracles, as in the other puparia of *Mesogramma*, are raised on blackened carinae.

Food Habits.—Not known.

Melanostoma Schiner and *Platychirus* St. Fargeau and Serville

Although the males of these two genera appear to be distinct, the females are very difficult to assign even to genus. The larvae, also, are so similar as to make it impossible up to the present to distinguish the genera.

The larvae of the two genera are both smooth, glossy-skinned, slightly flattened, and maggot-like. They are characterized by an unusual transparency of the integument and by almost sessile posterior spiracular plates which have a dark triangular field around them.

The larvae of both genera are nocturnal and show a strong preference for quite moist situations. When disturbed, they become very active and display the most remarkable speed of travel that the writer has observed in any syrphid.

The two genera seem to present a transition group in food habits. Metcalf (1916) records finding a large number of *Melanostoma melinum* larvae on rape plants infested with *Myzus persicae*, but the aphids were much fewer in numbers than the predators. He reared the larvae in the laboratory on *Aphis cornifoliae* Fitch and *Myzus persicae*, but the larvae refused other species. Davidson (1922) observed that *M. stegnum* raised on a diet of aphids became undersized imagines, suggesting that aphids were not their normal diet. He records the observation of Curran

that the larvae of *M. obscurum* consumed both aphids and decomposing chickweed and that they were more successful on the chickweed. In Davidson's cages, there was no decomposing plant material. He makes an interesting suggestion: "It is possible that several of the species of *Melanostoma* are both phytophagous and entomophagous in the larval stage, and that even these are undergoing a transition in habit, changing from plant to insect feeders. The nocturnal habit of feeding and desire for concealment suggests that it may not have been so long ago that the larvae normally lived in obscurity inside plants, or in the open in darker situations than growing plants normally afford."

The larvae of *Platychirus quadratus* have been taken by the writer on rape where there was an apparent absence of aphids. On the other hand, Metcalf (1917) reared *P. perpallidus* from eggs in the laboratory on *Aphis cornifoliae*, and Fluke (1929) records taking hundreds of the larvae of *P. hyperboreus* from alfalfa infested with *Macrosiphum pisi*. He also collected *P. quadratus* among *Hyalopterus pruni* (Geoffroy), an aphid of *Phragmites*. Verrall (1901) states that *P. scutatus*, an European species, "is said to have been bred from rotten fungi." Although the latter record is doubted by some authors, it may be said that the larvae of *Platychirus* exhibit a tendency toward variable feeding habits similar to that of *Melanostoma*.

Of the following species, the writer has seen the living larvae of *Platychirus quadratus* only, although she has been able to examine several species of puparia. The characters of the puparia and those given in the descriptions of other authors have been insufficient to separate the species in this group.

Melanostoma mellinum Linnaeus

The larva and puparium have been described in detail and figured by Metcalf (1916). The author has not seen the larva of this species, and the following description has been taken from his paper. The description of the puparium was made from a single specimen in the immature collection of the Department of Entomology at the University of Illinois.

Description of Larva.—Length, when well extended, 8-9 mm., width 2.5 mm. Color lettuce-green, a little more yellowish mediad. Since the integument is unusually transparent, the viscera show through the body wall with unusual plainness.

The integument is finely papillose without vestiture. The segmental spines consist of a fleshy, subconical base surmounted by a slender, blunt peg of about equal height, the whole small, light colored, entirely inconspicuous.

The posterior respiratory process is about 0.3 mm. broad at the end, about 0.17 mm. in height and elevated above the surface of the last

segment only to a length of about 0.1 mm. The circular plate is evident, and the pairs of spiracles are unusually short: less than twice as long as broad. The interspiracular ornamentation consists of four pairs of short rounded nodules. There is a moderate emargination between the two posterior spiracular plates.

Puparium (Fig. 19).—Length, 6 mm., width at anterior end, 2.25 mm., height, 1.7 mm. General body form clavate, sloping in narrow ridge down to posterior respiratory process. Color yellowish green, translucent, with tendency towards opalescence.

Under either the highest power of a binocular microscope or under the low power of a compound microscope, the pupal respiratory horn is clearly evident as a small reddish brown projection rising from the dorsal plate of the operculum. It is slightly longer than its diameter. The eight oval areas figured by Metcalf (Fig. 19) are difficult to see on the specimen examined by the writer. The features of the posterior respiratory process are the same as those of the larva, but the spiracles are surrounded by a black triangle.

Food Habits.—From eggs deposited on rape, and larvae found in moist places near the ground under the leaves of rape, Metcalf (1916) reared this species in the laboratory on *Myzus persicae* and *Aphis cornifoliae* Fitch from *Cornus*. His records do not absolutely establish whether the larvae were aphidophagous in the field or were feeding on rotting material in the moist situations at the base of the plants.

Melanostoma obscurum Say

The adults of this species are not uncommon in the Illinois region and are very generally distributed over the United States. The author has reared puparia loaned by Dr. C. L. Fluke but is unable to distinguish these in any way from those of *M. mellinum*. The posterior spiracular plates are shown in Fig. 21.

Platychirus quadratus (Say)

The puparium and posterior respiratory process of this species were figured by Metcalf (1913) but no description was given. Fluke (1929) figures the posterior spiracular process and a parasitized puparium.

Description of the Larva.—Length, 10-12 mm., width, 2.25 mm., height, 2 mm. The color is bright, rich orange to translucent orangish brown with the visceral bodies variously modifying the general coloration through the transparent integument. There are two dull white sub-lateral visceral lines similar to those in *Sphaerophoria* (Fig. 1).

The body is distinctly spindle-shaped with a broad, flat, truncate

posterior segment. The secondary wrinkles are slight and inconspicuous, the segmental spines minute.

The posterior respiratory process is a light reddish brown, almost concolorous with the body color and projects but slightly above the surface. The three posterior spiracles are located in a roughly triangular field, frequently darker than the rest of the plate, and always so in the puparium. The writer has been unable to find in *P. quadratus* the denticles along the sides of the spiracles as described by Metcalf for *P. perpallidus*. The interspiracular nodules are exceedingly minute and located on the triangular field. The circular plate is prominent, with a distinct rim and fine radiating lines in its disk.

Puparium.—Length, 6 mm., width, 2.5 mm., height, 2.3 mm. The shape is more inflated than that figured for *Melanostoma mellinum* (Fig. 19) having a distinct convexity posteriorly. The color is strawytan; in later puparia, the pattern of the adult shows through the puparium. The posterior respiratory process is similar to that of the larva except for increased pigmentation around the spiracles.

Food Habits.—The larvae were reared from eggs laid by adults caught hovering around rape; they were reared in the laboratory on *Myzus persicae*.

Platychirus hyperboreus Staeger (= *Platychirus erraticus* Curran)

The stages of this species are very completely described by Fluke (1929) from Wisconsin where it is a very important predator of the pea aphid. He figures the puparium and the posterior spiracular plate, and gives in addition photographs of eggs, a larva, and puparia. The species occurs in Illinois but the larvae have not been seen by the writer. The following descriptions have been condensed from Fluke's account.

Description of the Larva.—Length, 11-11.5 mm., width, 2.5 mm., height, 2 mm. The predominating color is pinkish salmon with the adipose tissue showing through principally as two sublateral lines. On each side of the dark and prominent heart line are several very irregular, interrupted lines of white.

The body is decidedly pointed anteriorly, the wrinkling gentle with few folds. The integument is very finely papillose without any spiny vestiture. The segmental spines are short, white, and inconspicuous.

The posterior spiracular plates are so similar to those of *P. quadratus* that the writer is unable to distinguish the two; Fluke gives the following tentative, but admittedly weak, distinguishing characters: *P. hyperboreus*: spiracles appear wider, circular plates with radiating, spreading grooves; *P. quadratus*: spiracles longer and more slender, circular plates with radiating, spreading lines, not grooves.

In this species, as in *P. quadratus*, the denticles around the spiracles described by Metcalf for *P. perpallidus* are lacking.

Puparium.—Length, 6 mm., width, 2.5 mm., height, 2.3 mm. Light brown in color. A few days before emergence the pattern of the adult becomes discernible.

Food Habits.—Fluke reared this species from *Macrosiphum pisi* on peas and alfalfa.

Platychirus perpallidus Verrall

The stages of this European species were described very carefully by Metcalf (1917) from Maine. His account is accompanied by figures of the eggs, larva, puparium, and adult. The description is taken from Metcalf's account.

Description of the Larva.—Length 10-11 mm., width at middle, 1.72-2 mm., height, about 2 mm. An elongate, slender-bodied larva with moderate wrinkling and gently irregular margin. The color is a beautiful bright tan. On each side of the darker heart line is a broad, whitish stripe of adipose tissue, giving off at the sides irregular curved tongues of white which form an indefinite broken stripe of white. A third pair of whitish stripes, slender, broken, and irregular, lie close to the lateral margins.

The posterior spiracular plates (Fig. 20) are almost sessile, the respiratory process being about 0.18 mm. long. The circular plates are distinct, the interspiracular nodules very small. Each spiracle has a row of separate minute rounded denticles along its margin, increasing its apparent width.

Puparium.—Length, 5.5 mm., width, 1.85 mm., height, 1.75 mm. The colors of the larva are at first carried over into the puparium but are gradually transformed to a uniform reddish brown. In side view the puparium is moderately inflated; from the maximum height about the anterior third it descends in a moderate hump over the posterior third to the posterior respiratory process.

Food Habits.—This species was reared in the laboratory on *Aphis cornifoliae* and *Aphis spiraecola* Patch by Metcalf (1917).

LASIOPHTHICUS Rondani

The representative of this genus, *Lasiophthicus pyrastris* Linnaeus, is a typically western species where, according to Essig, (1926), it is the most abundant and beneficial as well as the best known syrphid. He says it is found in every western state, including British Columbia in Canada. The larvae are voracious and general feeders and the adults strong fliers. Fluke (1929) believes that it would be practical to introduce this valuable

species into Wisconsin, where another western species, *Eupcodes volucris*, has already become established accidentally. Because this species is so important in the West and may eventually become common in Illinois, it has been included in this paper.

Lasiophthicus pyrastris Linnaeus

The larva and puparium of this species were described in detail and figured in colors by Jones (1922). Campbell and Davidson (1924) describe the same stages rather briefly and discuss the food habits; they give a photograph of the larvae. Essig (1926) discusses the stages briefly in "Insects of Western North America." Fluke (1929) figured the posterior spiracular plates, and a description of their features was given.

For this species, three names are in common use, *Scaeva pyrastris*, *Catabomba pyrastris*, and *Lasiophthicus pyrastris*. The writer is following Aldrich in using *Lasiophthicus* as the generic name.

The material for the drawings was kindly loaned by Dr. C. L. Fluke and came originally from California. The descriptions have been in part adapted from the authors mentioned above and in part taken from preserved specimens.

Description of the Larva.—Average length, 14-16 mm., width, 3.5 mm. Pea-green to a brownish green, a lighter green anteriorly and more yellowish posteriorly, with a narrow dorsal, longitudinal, white stripe and two fainter and more irregular white dorso-lateral stripes, growing darker posteriorly. The line of the dorsal blood vessel is inconspicuous.

The body is subcylindrical, tapering anteriorly and truncate posteriorly, irregular in outline and very much wrinkled transversely. The segments are distinct. The integument is papillose and covered with microscopic pale setae. The segmental spines are short and inconspicuous.

The posterior respiratory process (Fig. 24) is dark brown and is shorter than the combined width of the tubes, basally contiguous and apically slightly divergent. The most characteristic feature is the position of spiracle II, which has shifted around and downward with the result that spiracles II and III are approximately parallel. The dorsal spine is wanting altogether. The circular plates are surrounded entirely by a thickened rim. The interspiracular nodules are minute and inconspicuous.

The chitinous bars (Fig. 22) in the posterior spiracles of this genus are more closely related to those of *Syrphus* than *Metasyrphus*. They consist of an irregular fringe of minute pegs on slightly different levels protruding into the openings. On the tips of every third or fourth peg is a slender rod, enlarged at the end.

Recognition Characters.—1. Large larvae (10-15 mm.) varying from green to brownish green with white longitudinal stripes. 2. Posterior

spiracles II and III approximately parallel and directed dorso-ventrally (Fig. 24). 3. No dorsal spine on posterior spiracular plate.

Puparium (Fig. 28).—Length, 8.5 mm., width, 3.5-5 mm., height, 3-3.5 mm. General color dark brown, tinged with pink. Anterior end inflated, tapering abruptly from beyond the middle to the posterior end. Dorsum broadly convex, venter fairly straight, slightly concave toward the posterior end. The posterior, rather square segment curls down under the body on pupariation in a characteristic little lip, exposing more fully the dark brown posterior respiratory process. The features of the spiracular plates are the same as those in the larva (Fig. 24).

Food Habits.—This species, like *Syrphus* and *Metasyrphus*, is a very general feeder. Jones (1922) records individuals from *Periphyllus negundinis* (Thomas) on box-elder, and he reared them successfully from *Aphis helianthi* Monell, *Aphis avenae* Fabr., *Aphis carbocolor* Gillette, *Brevicoryne* (*Aphis*) *brassicae*, *Aphis pomi* de Geer, *Macrosiphum solanifolii* (Ashm.), *Myzus cerasi*, and *Clavigerus* (*Melanoxanthus*) *bicolor* (Oestlund). He noted that in the cages they were even cannibalistic. Campbell and Davidson (1924) record them, in addition, from *Aphis gossypii*, *Aphis maidis*, *Brevicoryne pseudobrassicae*, *Macrosiphum pisi*, *Macrosiphum albifrons* Essig, *Macrosiphum rosae* (Linn.), *Myzus persicae*, and *Chromaphis juglandicola* (Kalt.).

EUPEODES Osten Sacken

Three species of the genus *Eupeodes* have been described. The best known, *volucris*, is a typically western syrphid and is one of the most abundant and important aphidophagous species of western United States, occurring in California throughout the entire year, according to Campbell and Davidson (1924), and especially in arid regions, according to Fluke. The writer has never collected specimens of this fly in Illinois and there are none in the collection of the Illinois State Natural History Survey, but Fluke (1929) records six specimens from Wisconsin between 1919 and 1926 and thinks it may in time become common in the Middle West.

The genus is very closely related to the genus *Syrphus*, and the larvae resemble those of *Syrphus*, being long, rather slender, and tapering anteriorly. Like *Syrphus*, they have a very short posterior respiratory process. The segmental spines are conspicuous. The most striking feature, which may be a generic one, is a peculiarity of the spiracular plates in which the angle between spiracles I and II is very great, so that the three spiracles are almost parallel to one another. No other syrphids show such complete divergence of the two upper spiracles, although, as Fluke has pointed out, *Lasiophthicus pyrastris* and *Syrphus meadii* approach it, but they are readily distinguished by other characters.

Eupeodes volucris Osten Sacken

Jones (1922) described the stages and figured the larva and puparium in colors. Smith (1923) gave a figure of the larva but no description. Campbell and Davidson (1924) also described the immature stages and gave a figure of the mature larva and a photograph of a partly grown larva. Fluke (1929) describes the posterior respiratory process and gives a figure of the spiracular plates.

The following descriptions were made from living larvae and puparia reared in Colorado by the writer.

Description of Larva (Fig. 25).—Length of mature larva, 9-14 mm., width, 2-3.25 mm. Typical maggot-like form tapering anteriorly, somewhat flattened and truncate posteriorly. The larva has a moderately spiny appearance, due to conspicuous segmental spines which consist of a long, blunt, peg-like distal segment on a broad basal segment (Fig. 26).

The color of the larva usually presents a greenish general appearance, streaked dorsally with soft pink and white, yellow and white, or green and white. A broad median band along the dorsum varies from soft flesh-pink, dull salmon, or yellowish to leaf-green. It is bordered laterally by two narrow, irregular white lines which follow the ridge of the dorso-lateral segmental bristles. Beyond these lines on each side the sides and venter are soft leaf-green, rarely dull straw-yellow. The median dorsal blood vessel is very narrow and inconspicuous. On the four segments just anterior to the posterior respiratory process are oblique brownish lines of variable distinctness due to minute brown cutaneous speckling.

The posterior respiratory process is light golden brown and normally recessed in a fleshy depression, so that in a living larva it is usually invisible from above. The process is short with a characteristic ventro-lateral chitinized lobe at the base of each tube. Only the upper spiracles have a carina. A sharp dorsal spur is present. The arrangement of the spiracles is distinctive, with spiracles II and III nearly parallel and vertical in position.

Recognition Characters.—1. Segmental spines in form of a blunt peg, four times as long as wide, on broad basal segment (Fig. 26). 2. Posterior respiratory process short (Fig. 23) with sharp dorsal spur, and the two lowest spiracles of each side approximately parallel to the median axis.

Puparium.—Length, 5.5-6.5 mm., width, 2.5-3 mm. Dorsum broadly convex; venter almost straight or slightly concave; the posterior end with a tendency to turn down under sole at tip. The color varies from light dun-brown to rich brown and may have from four to seven dorso-lateral black spots formed by the concentration of the brownish, oblique stripes of the larva. The prominent peg-like segmental spines are visible all

over the surface as translucent yellow tags if the puparium is clean. Often it is covered with dirt from the soil surface on which pupariation usually occurs. The posterior respiratory process is more prominent than in the larva, since the contraction of the integument causes it to be exerted, but the recognition characters are the same.

Food Habits.—*Eupeodes volucris* has been reared from *Periphyllus negundinis* on box-elder, *Aphis helianthi* on *Cornus*, *Aphis viburnicola* on snowball, *Myzus cerasi* on cherry, and *Capitophorus ribis* (Linn.) on currant. Jones (1922) also records it from *Aphis carbocolor* on *Rumex*, *Pemphigus betae* Doane on beets, *Macrosiphum pisi* on alfalfa, and from *Aphis avenae* on cat-tail. Campbell and Davidson (1924) have taken it on *Brevicoryne brassicae*, *Brevicoryne pseudobrassicae*, *Aphis gossypii*, *Aphis maidis*, *Aphis rumicis*, *Macrosiphum rosae*, *Myzus persicae*, *Myzus braggii* Gillette, *Rhopalosiphum lactucae* Schrank, and *Myzocallis californicus* var. *pallida* Davidson, hosts not given. Smith (1923) lists it as an important predator of *Anuraphis bakeri* Cowen, the clover aphid.

SYRPHUS Fabricius

The genus *Syrphus* contains some of the commonest and most conspicuous of aphid predators. So far as is known all the species of this genus are aphidophagous and are general feeders, found on many species of aphids.

The larvae are medium-sized or large (10-17 mm.) robust maggots. They are bare of bristles except for the very minute and usually pale, scattered segmental spines (Fig. 34). The integument, however, is pebbled with very small, hyaline, rounded papillae. The posterior respiratory process is very short and appears smoothly rounded because the interspiracular nodules are small and there are low, or no, carinae around the spiracles (Fig. 31).

The spiracles are peculiar for a fringe of minute parallel bars (Fig. 35) guarding the opening just below the surface of the rim. These may be plainly seen under the high power of a compound microscope in the spiracles of any of the species of this group. Below the fringe of bars is a broadly fusiform basket of large chitinous bars which appears to strengthen the walls of the atrium. Their presence gives a slightly bulbous swelling (Fig. 30) to the surface around the spiracle. The swelling is not great enough to be considered a carina and may be altogether lacking in some specimens.

The color pattern follows a similar design in all the species (Fig. 29). The dorsal blood vessel is a dark median line which may be brown or black. On each side of the dorsal blood vessel runs a very narrow in-

interrupted band of a bright color which the writer has called the *dorsal line*. Each dorsal line usually has at the same relative point on each segment, a knot-like thickening. Laterad from the dorsal line is an open area of translucent brown or dense black. It receives its color from the internal fluids and is limited in shape and size laterally by fatty masses; since this area, combined with the symmetrical one of the same segment, is usually in the shape of an arrowhead pointing forward and broadly joining the same area in the next segment, it has been called the *arrow*. The large fatty masses, which run midway down each half of the larva and form a segmented pattern of wedge-shaped areas, have been called the *chevrons*. These are yellow, white, or pale pink and grow more extensive in the late larvae, invading and obliterating the brownish or black arrows. When the accent of dark color is removed, and with some fading of the dorsal line, the whole bright pattern changes to a monotonous pinkish yellow or white, and accounts for the fact that two larvae of apparently very different color patterns are the same species.

The larvae of the genus *Syrphus* are readily distinguished from those of the most closely related genus, *Metasyrphus*, by a lack of spiny vestiture which is present in *Metasyrphus*; by a smoothly rounded spiracular plate with no high carinae, while the plate is angular with high carinae in *Metasyrphus*; by the presence of parallel chitinous bars in the spiracle of *Syrphus* but a perforated plate in that of *Metasyrphus*; and by relatively more robust, broader larvae than those of *Metasyrphus*.

The rectal gills are a pair of double finger-like structures joined at the base, one pair on each side of the rectum. They are alike in all of the species (Fig. 32).

KEY TO SPECIES OF SYRPHUS

(Colors are those of living specimens)

- Posterior respiratory process with large, high, irregularly ridge-like interspiracular nodules; process twice as long as height at tip (Figs. 38, 39).....*S. knabi*
- Posterior spiracular tube with smoothly rounded, or oval interspiracular nodules; tube usually only about as long as it is high (Figs. 30, 31)..... 1
1. Nodules all located close in to center of spiracular plate, and of about the same size and shape; the circular plates distant from dorsal margin by three-fourths their height; usually smaller larvae (Fig. 33).....*S. torvus*
- Nodules not all same size and shape nor close in towards center; circular plates less than one-half their height distant from the dorsal margin; usually large to very large larvae (Figs. 30, 36)..... 2
2. Red, black, and yellow and over 14 mm.....*S. ribesii vittafrons* (Fig. 36)
- All white, or all pink chevroned, or red, brown, and white and not over 14 mm.....*S. rectus* (Fig. 29)

Syrphus rectus Osten Sacken

So far as the writer knows this larva has not been described. Fluke (1929) figures the posterior spiracular plate and compares it briefly with those of *S. ribesii* and the variety *S. ribesii vittafrons*.

This species is common from spring until late in the fall and with *S. ribesii vittafrons* makes up the majority of the larvae of *Syrphus* found in this region. Unfortunately, the larvae of the two species, unless in full coloration, are very difficult to distinguish.

Larva (Fig. 29).—Length, 13 mm., width, 3.5 mm., height, 3 mm. The larva is a rather large, robust maggot, somewhat broader than high with a glossy, smooth skin crossed by numerous shallow wrinkles. The integument is bare but covered with rounded hyaline papillae (Fig. 34). It is perfectly transparent so that the color pattern of the larva is formed by the colors of subcutaneous structures.

This species appears to occur in two color forms. In the spring, the chevrons are white or salmon pink, very large, and cover most of the area normally occupied by the arrows. The general appearance is of a largely white or pink larva with a slender black dorsal line, interrupted, as if dotted, with four slender black diagonal lines on each side, directed caudad, forming four V's with their points forward. The dorsal line is not distinguished from the chevrons, but sometimes the fatty masses are yellowish or tinged strongly with pink only near the midline. The sides are always translucent greyish white.

In the summer and late autumn, the larva is a beautiful snake pattern of russet brown and white. The dorsal blood vessel is a black median line bordered on each side by a rich brick-red dorsal line. The arrows are deep brown to black, but in either case to the unaided eye they appear, with the red, as a rich brown dorsal stripe. The chevrons are dead white and the lateral margins brownish, translucent, light grey. As this larva approaches pupariation, the chevrons become more extensive, obliterating the black, and the red dorsal line becomes paler. Soon the black has completely disappeared; the chevrons take on a salmon cast and the brown and white larva becomes a dull pink very similar to a late stage of either *ribesii vittafrons* or *torvus*.

The posterior respiratory process (Fig. 31) is just about as long as it is high at the tip (about 0.3 mm.). The posterior spiracular plate (Fig. 30) is disc-like, smooth, and evenly rounded at the edge. On each plate are three pairs of simple spiracles and four pairs of small, distinct, well-rounded interspiracular nodules; the circular plates are somewhat higher than broad. There is a prominent curved ridge mesad from each spiracular plate, a structure corresponding to the dorsal spine

of other genera. Fluke believes the posterior respiratory organ smaller in *S. rectus* than in *S. ribesii vittafrons* and *S. torvus*.

Recognition Characters.—Usually smaller than that of *Syrphus ribesii vittafrons*. The nearly all white, or the russet brown and white pattern is readily recognizable, but when in the pinkish dun stage, the larva looks like that of *S. ribesii vittafrons*. The posterior spiracles afford no known distinctive characters.

Puparium.—Length, 7 mm., width, 2.8 mm., height, 3 mm. The puparium, in contrast to the larva, is rather readily distinguished from the pupa of *ribesii vittafrons*. It is slender, not inflated in outline, and somewhat smaller than the other species. It has a distinctive black lattice-like pattern of X-shaped bars on the sides, against a background of light tan. There is a wavy, tan, lateral line. The dorsum is usually an unmarked tan except for a few median black dots or bars near the posterior respiratory tube. A very few puparia show no color markings.

Food Habits.—The larvae of this species have been taken by the writer among *Aphis spiraeicola* Patch on flowering almond and *Aphis viburnicola* Gillette on viburnum in the spring; among *Rhopalosiphum rhois* Monell on sumac and *Aphis rumicis* Linn. on curly dock in the summer, and among *Myzocallis alhambra* on oak, *Aphis oestlundii* Gillette on evening primrose, *Myzus persicae* on cabbage, *Macrosiphum gei* (Koch), and *Macrosiphum ambrosiae* (Thomas) on wild lettuce in autumn. Fluke records it from *Macrosiphum pisi* on peas in Wisconsin. At Urbana, it was taken by Mr. B. D. Burks feeding on *Cinara laricis* (Hartig) on larch.

Syrphus ribesii Linnaeus

Syrphus ribesii is a large species found only in the northern and western regions of the United States. The writer has seen no specimens of the larva, but it is presumably similar to its variety, *ribesii vittafrons*, which is abundant in Illinois. Fluke (1929) gives a figure of the posterior spiracular plate and compares it with *vittafrons*. He lists it as a rare predator of *Macrosiphum pisi* on peas in Wisconsin.

Syrphus ribesii vittafrons Shannon

This larva is extremely common in June and again in the fall; the writer has found it very scarce during August. This may be due to two generations a year or to accidents of the two seasons in which the work was carried on. Fluke has figured the posterior spiracular plates and given the measurements of the larva; his description of the larva is very brief.

Larva.—Length, 12-15 mm. at rest, 17 mm. or more when extended, width, 3.5 mm., height, 2.8-3 mm. This is easily the largest known larva of the *Syrphus* group. Otherwise it is very similar in its robust shape to the others.

The color pattern at its brightest is quite striking; jet black, bright red, and yellow. The dorsal line is scarlet, the arrows black and the lateral chevrons clear rich yellow or cream. The sides are translucent grey or dun. In late larvae, the dorsal line fades to pinkish orange, or yellow with pinkish knots; the chevrons take on a salmon-pink cast; the black fades out of the arrows leaving them narrow and grey. The result is a pinkish yellow, vaguely snake-patterned larva very similar to that of *S. rectus* and *S. torvus*. The spiracular plate (Fig. 36) cannot be distinguished from *rectus* by any constant characters.

Puparium (Fig. 37).—Length, 8 mm., width, 4 mm., height, 4 mm. The puparium is very large and has an inflated appearance. It is evenly rounded at the anterior end, curves gently down for three-fourths of the body length and then bends abruptly to the base of the posterior tube. The integument is light yellow-brown with a silky sheen and no trace of any dark markings. The integument is smooth but marked with numerous tiny parallel lines, traces of the larval wrinkles.

Food Habits.—The larvae of this species have been taken among *Aphis viburnicola* on snowball and *Aphis rumicis* on curly dock during June and July. In the fall, it was taken among *Macrosiphum rudbeckiae* (Fitch) on wild golden-glow and *Macrosiphum sanborni* Gillette on chrysanthemum, among *Macrosiphum ambrosiae* (Thomas) on *Verbasina* and wild lettuce. In addition, Fluke lists this species from *Macrosiphum pisi* in Wisconsin.

Syrphus torvus Osten Sacken

The larva and puparium were described in detail by Metcalf (1911a) and a figure of each, accompanied by enlarged details, was given. Later, briefer descriptions by the same author were published in 1913 and 1916. Fluke (1929) does not describe the larva but gives the characters of the larval posterior spiracular plates and figures them. According to Metcalf (1913) the larva has also been described by J. B. Smith (1890); the writer has not seen this paper.

Syrphus torvus is most common in Illinois in the spring, and only a few were reared during the summer in comparison with great numbers of other species of *Syrphus*; however, it is widely distributed over the United States. The adults vary considerably in size from rather small flies to large robust individuals.

Larva.—Length, 10-13 mm., width, 3-4 mm., height, 2.5 mm. In the

second instar the larvae are ebony black, brick red, and white; the black gradually becomes brown, and in the third instar the general coloration is brownish pink with yellowish chevrons. The coloration is deceptively similar to that of the larvae of *S. ribesii vittafrons*, but the larvae of *S. torvus* are smaller in general.

The posterior respiratory process (Fig. 33) is short, not more than one and a half times the height of the tube at its tip. The spiracular plate is very smooth and rounded, with small distinct interspiracular nodules, placed unusually close to the center of the plate. There is a broad shoulder of the spiracular plate above the circular plate, about three-fourths the height of the circular plate itself; this distance to the edge is much greater than in any other known species of this group and is accompanied by a shift of the dorsal spur nearly to the midpoint of the spiracular plate.

Puparium.—Length, 7-10 mm., width, 4 mm., height, 4 mm. Light golden brown, naked, smooth, and with a silky sheen. In some specimens there is a series of six or seven small black dots in a median dorsal row from the anterior curve back to the base of the projecting respiratory tube; curving along each mid-lateral region is a wavy, slender, dark lateral line. The characteristics of the posterior respiratory process are the same as those of the larva.

Food Habits.—The larvae have been taken among *Macrosiphum ambrosiae* on wild lettuce (*Lactuca*) and *Verbasina*, among *Macrosiphum sanborni* on chrysanthemum, and among *Macrosiphum rudbeckiae* on wild golden-glow. Metcalf records them from *Aphis brassicae* on cabbage, more rarely among *Longistigma caryae* (Harris) on sycamore in Ohio, from *Aphis spiraecola* on spirea, and from *Phorodon humuli* (Schränk) on plum seedlings in Maine. Fluke records this species from *Macrosiphum pisi* in Wisconsin.

Syrphus knabi Shannon

The immature stages of *Syrphus knabi* were first described by Metcalf (1913a) under the name *Syrphus xanthostomus* Will., with some doubt as to its identity; the accompanying plate gave an outline of the larva and puparium and several details of the larva. A briefer description by the same author is given and figured in "The Syrphidae of Ohio" (1913b). In 1916, Shannon described the adult as a distinct species, and the following year Metcalf (1917) redescribed the larva and puparium under the new name of *Syrphus knabi*.

The larvae seem to prefer aphid colonies in protected situations. In Ohio, Metcalf reared this species from the vagabond galls of poplar and American aspen, where they fed on the gall-forming aphid *Pemphigus oestlundii* Cockerell. In these cramped quarters they were strongly arched,

stoutly broad, and very sluggish. In Maine, the larvae were found in the tightly curled leaves of ash caused by *Prociphilus fraxinifolii* (Riley). The writer found the larvae only in the tightly curled leaf-rolls of *Georgiaphis ulmi* (Wilson). Such situations are almost as well protected as within the cavity of the vagabond gall; these latter larvae were not so limited in their positions and consequently were not exceptionally thickened and shortened, nor were they so sluggish as the first. They are, however, quite robust larvae. It is interesting to note that all the aphid hosts are pulverulent.

Larva.—Length, 14-15 mm., width, 4 mm., height, 3 mm. Broad, thick larvae of the usual *Syrphus* type; general coloration, rosy pink and white of rather indefinite pattern. The ground color is soft, translucent grey overlaid with pink or orange visceral globules alternating with white in the typical segmented chevron pattern. The dorsal blood vessel shows as an interrupted median black line; the sides and venter, greenish translucent grey. The posterior respiratory process is bright brown.

The segmental spines of *S. knabi* are sometimes quite prominent under the microscope because they are usually bright brown like the posterior process. However, they are small and short and, to the naked eye, nearly indistinguishable.

The posterior respiratory process (Fig. 39) is notably longer than that of any of the other *Syrphus* species. In lateral view, it is slightly more than twice as long as it is high at the tip. In *torvus* the length does not exceed the height at the tip. Beyond the middle of the tube is a slight constriction; proximal to this the tube is darker brown, slightly rough, and dull in texture; distally, a clear, translucent polished brown. The interspiracular nodules of the posterior spiracular plate (Fig. 38) are unusually high and roughened, especially those of the ventral outer angle which are irregular carinae extending over the edge of the plate. All are much higher than the spiracles. The plate-like ridge at the dorsal inner angle of the spiracular plate is well developed.

Puparium.—Length, 7 mm., width, 3.5 mm., height, 3.5 mm. Color, light golden, shining brown. The puparium is often more or less marked with black; the most fully colored specimen has five V-shaped dark bands on the dorsum, the points directed caudad. The puparium is of the usual nearly rounded shape of this group but not so inflated as that of *S. ribesii vittifrons*. The posterior respiratory appendage has the same distinctive characteristics as that of the larva.

Food Habits.—*Syrphus knabi* has been taken in the larval stage feeding on *Georgiaphis ulmi* (Wilson) in curled leaves of slippery elm (*Ulmus fulva*) and, by Metcalf, on *Prociphilus fraxinifolii* in the curled leaves of

ash (*Fraxinus* sp.) in Maine and on *Mordwilkoja vagabundus* (Walsh) in the galls of aspen (*Populus tremuloides*) in Ohio. Fluke has recorded this species from *Macrosiphum pisi* on peas.

METASYRPHUS Matsumura and Adachi

The genus *Metasyrphus* contains a large number of species, but the larvae are difficult to separate and in some cases have been described under several names. This genus, like *Syrphus*, includes some of our commonest and most economically valuable species; all are general feeders on many kinds of aphids.

The larvae are medium-sized to large (10-15 mm.) but the larvae of the commonest species, *Metasyrphus wiedemanni*, as a rule, are smaller than *Syrphus* larvae. They are slenderer maggots, conspicuously transversely folded and with rather distinct dorso-lateral lengthwise ridges. The integument is closely set with minute spicules which are often soot-black. The posterior respiratory process is very short and deeply recessed in the fleshy folds of the last segment (Fig. 40). From above, the tubes appear diverging. The posterior spiracles (Fig. 45) are raised on high polished carinae and give to the posterior spiracular plate a narrow, angular appearance. The dorsal spur of the spiracular plate is short but sharply pointed.

The spiracles in this genus are characterized by a perforated chitinous plate situated just below the spiracular rim (Fig. 41) comparable to the fringe of chitinous bars in *Syrphus*. It is readily visible, even in uncleaned specimens, under the high power of the microscope. Fluke (1929) says of these, in his discussion of *Metasyrphus wiedemanni*, "It is possible that these bars are for protection to the trachea from foreign matter but they may also serve as bars for rigidity of the spiracles, internal apophyses which hold the spiracular slits open."

The rectal gills are alike in all species, a pair of double finger-like structures joined at the base, on each side of the rectum, as in *Syrphus*. In Fig. 48 they have been shown extended.

KEY TO SPECIES OF METASYRPHUS

- With elaborately convoluted posterior spiracles (Fig. 42).....*nitens* (?)
- Posterior spiracles simple slits (Fig. 47)..... 1
- 1. Posterior spiracles II and III much closer together than I and II; the angle between I and II about twice as great as that between II and III (Figs. 43, 44)..... 2
- Posterior spiracles II and III not much closer together than I and II; the angle between I and II only slightly greater than between II and III (Fig. 49)..... 3

2. Small species, under 10 mm., color pattern remarkably like bird excrement.....*canadensis*
Large species, 12-15 mm., light greenish with numerous brown fat bodies...*meadii*
3. Posterior spiracles I projecting laterally so that the distance between their outer ends is greater than that between the outer ends of posterior spiracles II; large (12-15 mm.), light tan or grey-tan larvae; no isolated patches of black setae (Fig. 47).....*perplexus*
Distance between the outer ends of spiracles I no greater than that between the outer ends of spiracles II (Figs. 45, 49)..... 4
4. Vivid green, red and white, or green, pink, and white larvae; no prominent circular patches of very densely set black setae (Fig. 49).....*vinelandi*
Brown and tan or brown and grey diagonally patterned larvae with evident circular patches of densely set black setae (Figs. 40, 45).....*wiedemanni*

Metasyrphus wiedemanni (Johnson)

The brown, diagonally patterned larvae of *Metasyrphus wiedemanni* (Fig. 40) are among the most widely distributed and most common of all the syrphid species. With the exception of *Sphaerophoria cylindrica* only, in this region, it surpasses all other species in value as a destroyer of aphids. Curran (1920) made a study of the numbers of aphids consumed by larvae of different abundant syrphid species. He found that *Metasyrphus wiedemanni* larvae consumed an average of twice as many aphids per day as any other species, but since their larval life is shorter than that of *Sphaerophoria cylindrica*, the latter larvae totaled more aphids per larva in their lifetime than *Metasyrphus wiedemanni*. The larva of this species is not only a voracious, but a very general feeder.

The immature stages were described by Metcalf (1912a) and figured in detail. In 1913b and 1916 briefer accounts were given by the same author. Jones (1922) described the stages of this species in Colorado and gave colored figures of the larva, puparium, and adult. Fluke (1929) gave a brief description of the larva, with particular reference to the posterior respiratory process and figured the posterior spiracular plates.

Larva (Fig. 40).—Length, 11-13 mm., width, 2.5 mm., height, 2.5 mm. The general effect is that of a knotty, wrinkled, brownish or greyish maggot with wedge-shaped tan marks down its back bordered by black diagonals, and on each side, a narrow lateral line of tan along the dorso-lateral carina. In detail the color pattern is as follows: the dorsal blood vessel is black or brown, interrupted by four whitish or deep flesh-colored transverse bars on segments 6 to 10. Lateral to it are slender dorsal lines of muddy white, tan, or pinkish globules which widen out into wedge-shaped chevrons of the same dull white or tan. Between these are black, prominent arrows, accentuated by surface vestiture of dark spinules. Running along the top of the dorso-lateral carina is a dull white or tan, somewhat undulating, lateral stripe. The sides are always translucent

grey. The actual colors may vary somewhat, but the brown diagonal pattern is always visible. When young, the larva tends to be strongly yellowish and very spiny.

The integument is closely set with microscopic black spinules, giving the whole surface a sooty appearance. In this species, especially, there are small lateral segmental patches of more densely set, black spinules with large, dark bases, usually located opposite the end of each dark arrow. The segmental spines (Fig. 46) are slender, two-segmented, light colored, and inconspicuous; the distal segment is about six to eight times as long as it is wide at the base.

The posterior respiratory process (Fig. 45) is red-brown and about as long as it is high. The posterior spiracles are slender, somewhat crooked slits on high, polished carinae, the median spiracle on each side somewhat nearer to the ventral than to the dorsal one. The ventral spiracles are usually almost parallel, but vary somewhat with individuals; in some they are slightly convergent at the tips. There is a sharp, but not high, dorsal spur on each posterior spiracular plate, projecting slightly higher than the highest spiracular carina. The interspiracular nodules are quite small and inconspicuous, and located near the proximal ends of the spiracles.

The species with which it is most likely to be confused is *perplexus*, and for the differentiation of the two species Fluke gives the following: *M. wiedemanni* larvae only 11 mm. in length, *M. perplexus*, 14-16 mm.; segmental spines light colored in *M. wiedemanni*, dark, almost black in *M. perplexus*; the interspiracular nodules are nearer the mesal ends of the spiracles in *M. perplexus*, and the lower spiracles incline to the midline of the organ with an angle of 2° in *M. perplexus* and an angle of 13° in *M. wiedemanni*. The last differentiation does not seem constant enough to the writer to be of value in differentiating the two species.

Recognition Characters.—1. Moderate-sized, greyish or brownish chevroned larvae (10-12 mm.). 2. Posterior spiracular plates not wider at level of outer tips of upper spiracles than at level of the outer tips of the second spiracles (Fig. 45). 3. Circular patches of enlarged black spinules in definite segmental positions (Fig. 40). 4. Segmental spines pale.

Puparium.—Length, 6.5-7.5 mm., width, 2.5-3 mm., height, 2.5 mm. The puparium is generally slenderer and trimmer than the plump type of *Syrphus* puparia; it is not strongly elevated posteriorly. The color is from light golden to rich chocolate-brown, always with a light feathering of black bars, produced by the concentration of integumental spines, and with dense, rounded spots on the dorso-lateral curvature. These are very rarely missing.

Food Habits.—The larva of this species was taken on nearly every common species of aphid: *Aphis gossypii* on muskmelon and cucumber,

Aphis spiraeicola on spirea and Japanese almond, *Aphis helianthi* on *Cornus*, *Aphis oestlundii* on evening primrose, *Aphis cardui* on thistle, *Aphis rumicis* on curly dock, *Aphis brassicae* on cabbage and rape, *Aphis sambuci* Linn. on elderberry, *Periphyllus negundinis* on box-elder, *Eriosoma lanigerum* (Hausmann) on apple, *Georgiaphis ulmi* on slippery elm, *Macrosiphum rudbeckiae* on golden-glow, *Macrosiphum sanborni* on chrysanthemum, *Rhopalosiphum pseudobrassicae* on turnip, *Myzocallis alhambra* on oak, and *Amphorophora cosmopolitana* on wild lettuce. Metcalf (1913b) records it on *Siphocoryne avenae*, the European grain aphid, on apple and on *Melanoxanthus salicti* on black willow, as well as an unknown aphid from *Phragmites*, a reed. Jones (1922) reports in addition *Clavigerus smithiae* (probably from willow) and *Macrosiphum pisi*. Curran (1920) gives a long list with *Aphis pomi* and *Myzus cerasi* in addition to those mentioned above.

Metasyrphus vinelandi (Curran)

The larva and puparium of *Metasyrphus vinelandi* were described by Metcalf (1913b) as an unusual variety of *Metasyrphus wiedemanni*, since the adults he reared came within his conception of that species (at that time under the name of *Syrphus americanus*). Curran, later, at Vineland, Ontario, described the adult of this striking larva as *vinelandi* (1921).

This larva is not so common as that of *Metasyrphus wiedemanni* but it is by no means rare. In the situations where it is found, as in the flower spikes of *Rumex*, in spite of its brilliant colors, it blends surprisingly well with the surroundings, so that it often escapes the eye entirely.

Larva.—Length, 10-15 mm., width, 3 mm., height, 3 mm. A very beautiful and striking larva with a color pattern as follows: lateral third of dorsum and sides, clear grass-green; on each side are chevrons of bright pink or red, shading to soft white or dull pink laterally; on the tubercles of the sixth to tenth segments are four white transverse bars, interrupting pinkish to deep rose dorsal lines. The arrows are narrow and black; the dorsal blood vessel is slender and black, interrupted into segments.

The whole dorsum is closely beset with colorless to brownish sharp slender spinules, the darker ones on the more exposed folds. The conspicuous segmental spines (Fig. 46) are very dusky or brown, usually darker than the body vestiture. Frequently only the terminal segment of the spines is fuscous. The dense patches of dark, larger spinules, so characteristic of *Metasyrphus wiedemanni*, are lacking in this species.

The writer is unable to find any constant feature of the posterior respiratory process (Fig. 49) which differentiates it from that of *Metasyrphus wiedemanni*.

Recognition Characters.—1. Bright green, red, white, and black color pattern. 2. Segmental spines fuscous. 3. No patches of dense, black-based larger setae.

Puparium.—Length, 6.5 mm., width, 3 mm., height, 3 mm. Metcalf (1913b) points out that the puparium is much broader and higher than that of *Metasyrphus wiedemanni*. In the latter, the ratio of length to height is 2.6:1, and of length to width, 2.5:1; while in *Metasyrphus vinelandi* it is as low as 2.15:1 for length to height, and 2.03:1 for width to height.

Food Habits.—This species has been taken from early June to late in the year among *Aphis rumicis*, on *Rumex crispus*, among *Rhopalosiphum rhois* on sumac, among *Toxoptera graminum* (Rond.) on wheat, among *Aphis oesthundi* on evening primrose, among *Macrosiphum sanborni*, and among *Macrosiphum ambrosiae* on *Verbasina*. Metcalf (1913b) took this species in Ohio feeding on *Aphis brassicae* on various Cruciferae, on *Siphocoryne avenae* on apple, on *Melanoxanthus salicti* on black willow, and on colonies of aphids on *Phragmites*. It is, like *Metasyrphus wiedemanni*, an effective predator with a long season of abundance.

Metasyrphus perplexus (Osburn)

The larvae and puparia of this species have been described by Fluke (1929) and the posterior spiracular plates figured.

Larva.—Length, 14-16 mm., width, 3 mm., height, 3 mm. The larva is very large, robust, cylindrical and grub-like. The general effect is soft grey-tan, with creamy tan along the midline and two dim interrupted darker streaks running lengthwise along the body just dorsal to the lateral carinae. There is no particular pattern.

The segmental spines are sharp, short, and dark colored. The integument is covered with definite diagonal patches of short, large-based sooty black setae.

The posterior respiratory process is very short, even for this group, being slightly less than its height in length, and it is deeply recessed in fleshy body folds. The posterior spiracular plates (Fig. 47) have a curious "eared" appearance due to the fact that the upper spiracles are shifted downward and outward at their outer ends, making the carinae more prominent and giving the posterior spiracular plate a greater width at this point. In some specimens they are directly opposite one another on a single straight line. The dorsal spines are high and sharp; the groove between the plates deep. The interspiracular nodules are very minute. The lower two pairs of spiracles are long and wide. The spiracles are always straight and simple, not irregular as in *wiedemanni*.

Recognition Characters.—1. Very large larvae, 14-16 mm., usually soft

greyish tan with indefinite color pattern. 2. Posterior spiracular plates have eared appearance; width from tip to tip of outer angles of upper spiracles noticeably greater than width of rest of posterior spiracular plate (Fig. 47). 3. No marked circular patches of sooty spines, in definite segmental positions as in *wiedemanni*. 4. Segmental spines dark, almost black.

Puparium.—Length, 7.5-8 mm., width, 3.5 mm., height, 3.5 mm. The puparium is well rounded with the posterior end bent downward abruptly, and the tip curled under, exposing the posterior respiratory tube much more than in the larva (cf. *Lasiophthicus* and *Eupeodes*). The puparium is light golden brown with a series of six dusky, diagonal bars on each side of the dorsum, formed by the concentrated patches of sooty setae of the larva, but it has no lateral series of round black spots.

Food Habits.—The larvae of this species were taken among *Macrosiphum ambrosiae* on wild lettuce and *Verbasina* and among colonies of *Macrosiphum sanborni* on chrysanthemum. Fluke (1929) in Wisconsin took them commonly feeding on *Amphorophora rubicola* (Oest.) on wild raspberry. He took them rarely on *Macrosiphum pisi*.

The writer collected one very small newly-emerged adult specimen from a rearing cage in which were *Pachypsyllus celtoideus* Riley galls. The leaves and galls were searched for a puparium to establish whether the syrphid had been feeding on the psyllid nymphs in the galls but none was found. It seems a matter of doubt whether even a small larva could develop in such a small space as the interior of these galls.

Metasyrphus meadii (Jones)

Metasyrphus meadii is, according to Fluke (1929), a typically western form, although specimens have been taken in Wisconsin, Ontario, and other eastern sections. Fluke points out that this species is the *Syrphus nitens* of western authors but not the *Syrphus nitens* described by Metcalf (1916) in which the posterior spiracles are highly convoluted. The account of Campbell and Davidson (1924) of *Syrphus nitens* which described the immature stages and food habits is presumably this species. The following descriptions have been taken from this paper. The figure was drawn from a puparium loaned by Dr. Fluke.

Larva.—Length, 12-15 mm., width, 3 mm. The body is laterally ridged. Observed closely, the color is greenish white, but the numerous, light brown fat bodies beneath the integument give a light brown color to the larva as a whole. The dorsal blood vessel is blackish.

The integument bears many areas of close-set blackish papillae, and the segmental spines are pale and rather short.

The posterior respiratory process (Fig. 44) is fuscous, its component tubes slightly divergent apically, each tube about as long as its basal

width. The arrangement of the posterior spiracles is different from any other species of *Metasyrphus* except *canadensis* and makes this species easy to recognize. Posterior spiracle II is much closer to posterior spiracle III than to posterior spiracle I, so that both II and III point ventrally.

Recognition Characters.—1. Large, greenish-brown larva (12-15 mm.), typically a western form. 2. Posterior spiracle II much closer to III than to I; posterior spiracles II and III both point distinctly ventrad (Fig. 44).

Puparium.—Length, 7 mm., width, 3 mm., height, 2.75 mm. The puparium is light brown with numerous black parallel bars in groups of three, each three forming a diagonal stripe in the typical herring bone pattern. The dorsum of the puparium is broadly convex, and the venter slightly concave. The posterior respiratory process is dark brown, short, bearing spiracles in the position of those of the larva.

Food Habits.—Campbell and Davidson (1924) report this species from the following aphids in California: *Aphis avenae*, *Aphis gossypii*, *Aphis rumicis*, *Brevicoryne brassicae*, *Macrosiphum pisi*, *Macrosiphum cucurbitae*, *Macrosiphum rosae*, *Macrosiphum pelargonii*, *Myzus braggii*, *Myzus persicae*, *Myzus rosarum*, and *Thomasia salicola*.

Metasyrphus canadensis (Curran)

The larvae of this species have not been seen by the writer, but several reared specimens with puparia attached have been loaned by Dr. C. L. Fluke.

The larvae are quite small, about 8 mm. in length, and according to Fluke (1933), who has followed their complete metamorphosis in Wisconsin, strongly resemble the excrement of birds in their coloration. They feed on *Periphyllus populicola* (Thomas) on *Populus* spp.

Puparium.—Unusually small for this genus, measuring 5-5.5 mm. long, 2.5 mm. wide, and 2.76 mm. high. On the posterior part of the dorsum are at least four distinct transverse dusky bands, deeply emarginate behind or completely interrupted. In some specimens there is a distinct, tan, arcuate dorso-lateral line at the edge of these bands. The posterior spiracular plates (Fig. 43) are in proportion to the size of the larva and somewhat smaller than in other species. The position of the median pair of posterior spiracles approaches that of *meadii*, where the median spiracle is distinctly closer to the lower than to the upper spiracle. The carinae of the two lower pairs of spiracles are unusually low.

Metasyrphus sp. (*nitens* Zetterstedt?)

The larva and puparium of this species were first described and figured by Metcalf (1916) as *Syrphus nitens* Zett., but Fluke (1929) after a careful study of the adult in comparison with European material concluded

it was not the same as *Syrphus nitens* Zett. The larva of *Metasyrphus nitens*, as described by western authors, is very different from this larva also, having simple straight spiracles and is described under *Metasyrphus meadii*. Fluke referred this species then to *M. venablesi* but other reared specimens of *M. venablesi* are attached to puparia with simple slits, which cannot possibly be the same as the species of Metcalf.

The larva is an aberrant form for this group as evidenced by the elaborate sinuous posterior spiracles (Fig. 42). In all other respects, it clearly seems to belong in this genus.

Although this species was reared by Metcalf (1916) in Maine and is not known from Illinois, it is so unusual that it merits inclusion in this paper. The descriptions are taken from Metcalf's account.

Larva.—Length, 15 mm., width, 3 mm., height, 2.5 mm. An unusually slender, elongate species. The twelfth segment is nearly a third narrower than the rest and somewhat depressed, the posterior end squarish.

In their natural habitat, the larvae were so covered with threads of flocculence from the host aphid as to appear light grey in color. When this is removed the color is yellowish brown, considerably mottled with black. The most conspicuous black markings are due to masses of body fluids showing through the integument; but others are formed by particularly thick areas of the black integumental spines. There are nine such areas on each somite, three on the middle line and three at each side.

The entire dorsum is beset with minute, black integumental spines; the segmental spines are situated on moderate, conical elevations and are light in color.

The rectal gills, four finger-like processes arising ventrally from the caudal segment, are not, in Metcalf's figure, as symmetrical as the typical two double pairs of this group (Fig. 48). The writer believes them incompletely extruded but not in any way unusual.

The posterior spiracles are remarkably and irregularly sinuate (Fig. 42), each situated along the top of a broadly rounded carina. The inter-spiracular nodules are small, rounded, inconspicuous.

Puparium.—Length, 7.6 mm., width, 3.75 mm., height, 3.85 mm. Color greyish-brown, with a mid-dorsal, broken blackish line, and an oblique lateral black stripe on each side of the segment due to denser patches of integumental spines. The puparium is bulbous in front, a little broader than high. The ventral line is quite concave, the dorsal line well elevated, with the greatest height about mid-length. A prominent dorsal carina widening out anteriorly extends forward from the posterior respiratory process. The latter structure retains its larval characteristics.

Food Habits.—Metcalf collected this species on *Clavigerus flocculosa* Weed on willow in Maine.

THE EMARGINATUS GROUP ("METASYRPHUS")

The genus *Xanthogramma* is one whose adult characters have been rather poorly defined and whose borders have suffered alteration. In 1931 Fluke pointed out, in his paper "Notes on Certain Syrphus Flies Related to *Xanthogramma* (Diptera, Syrphidae)," that the original characterization by Schiner limits the genus to one known species in North America, *Xanthogramma flavipes* Loew. He placed all the other species which had been ascribed to *Xanthogramma* in the genus *Syrphus*. In a later paper (1933) he removed this group to the genus *Metasyrphus* Matsumura and Adachi and treated them as a distinct sub-group, the "*emarginatus* group," but indicated that they warranted still further isolation from related forms. He suggested the genus *Olbiosyrphus* might possibly be used to include this group.

An examination of the larvae strongly bears out the advisability of including the "*emarginatus* group" in a genus of its own. The striking and beautiful body form makes them readily recognizable at a glance. They are strongly flattened dorso-ventrally, broadly ovate from above and fringed around the margin with deep serrations. They show no resemblance whatever to the cylindrical, compact, unornamented larva of *Xanthogramma flavipes* (Fig. 96), which may be taken as a typical representative of the genus. Another *Xanthogramma* similar in appearance to this larva has been figured by Vimmer (1933) from Czechoslovakia. The relatively long posterior respiratory process of the *emarginatus* group bears spiracles which are straight, simple slits on low carinae; the short, stump-like process of *Xanthogramma flavipes* bears spiracles which are tortuous loops flat on the surface of the spiracular plate. On the other hand, the *emarginatus* group larvae do not resemble those of *Syrphus* or *Metasyrphus* any more closely. Both of these genera have long, slender, tapering larvae which are subcircular in cross section; both have relatively short posterior respiratory processes and in *Syrphus* (but not *Metasyrphus*) the spiracles lack carinae.

The larval characters strongly point to the need for a new genus, but the writer feels that this move is already indicated, and that a new genus cannot be erected on the basis of larval characters. In this genus *innotatum* are included *Scaeva emarginata* Say which was later changed to *Xanthogramma emarginata* by Williston, *Syrphus weborgi* Fluke, *Xanthogramma divisa* Williston, and *Syrphus invigor* Curran.

The species of this group, where the larvae are known, form a homogeneous group of distinctive, flattened, serrate-edged larvae whose extreme similarity makes them difficult to separate. Of the species whose larvae are known, *divisus* and *invigor* can be distinguished from the others, but the writer is as yet unable to separate the immature stages of

"*Metasyrphus*" *emarginatus* from those of "*M.*" *weborgi* with any certainty. Although the stages of "*Metasyrphus*" *weborgi* were described in detail by Metcalf (1917) and *emarginatus* by Fluke (1931), who gives tables of comparative measurements of the two larvae, whatever differences may be found in the two accounts fail when compared with the actual specimens. The same differences in average measurements between the two species can be found between individuals of the same species. It might be suspected that the two species were not distinct, if the adults were not very clearly distinct and sharply separated.

The larvae of the *emarginatus* group are rather sluggish and, on the plant where they are found, look somewhat like a blighted area or leaf scale. All the known larvae are aphidophagous. In captivity they feed readily and soon come to full size, but then, instead of pupariating, waste away in complete inactivity and finally, after weeks or months, die. However, if placed in a flower pot with grass and leaves and left out of doors in all kinds of weather, the larvae will pupariate normally and emerge as satisfactorily as other syrphid larvae. This peculiar reluctance to transform under ordinary laboratory conditions is so uniform that it may be called a physiological character of the *emarginatus* group. *Xanthogramma flavipes*, on the other hand, pupariates readily.

Larva of the "emarginatus" Group (Fig. 50).—Length, 7 mm. (*divisus* contracted) to 10.5 mm. (*emarginatus*, extended), width, 5-5.5 mm. Dorso-ventrally flattened; when at rest, a broad oval, narrower at the anterior end. When contracted, there are nine segments visible from above, the most anterior one of which is the fourth segment. The first three body segments are retracted under the sharp, spiny margin of the fourth segment, but in activity they are extended in a tapering cone similar to the anterior end of a typical syrphid larva. On the concealed third segment are found the minute anterior spiracular processes.

The lateral margins of the larva are continuously serrated with pointed lobes, three large subequal serrations and one small serration to each segment on segments five to eleven inclusive. The twelfth has only one large and one small lobe. Each of the large lobes bears a short segmental spine, but the small fourth lobe has none. The median dorsal and dorso-lateral segmental spines are minute, pale, and inconspicuous but present on the dorsum in their normal positions. Each spine (Fig. 56) consists of a slender distal piece about four times as long as it is broad and pointed at the tip, on a short basal piece which is almost ball-like in its proportions and more than twice as broad as the distal spine. The whole fleshy lobe is ornamented with rings of coarse granules.

The integument of the larva is moderately wrinkled, delicate, glossy and transparent. It is without vestiture, but over the dorsum it is covered with minute papillation that grades imperceptibly into the coarse papillae

of the lateral lobes and of the truncated anterior and posterior edges. Since the skin is transparent, all color is due to that of subcutaneous fatty masses. These are collections of rather small and rounded globules in definite patterns but they are somewhat movable. Along the midline they pulsate with the heart movements.

The posterior respiratory process (Fig. 57) is always more than twice as long as it is broad at the tip. The two tubes are completely united in the basal half, so that no trace of a median groove is visible. This portion is roughened by coarse nodules. The distal half is grooved sagittally, above and below, by a shallow median groove and bears smaller papillae than the basal half. From above, the process tapers gradually from a broad base to about the midline, where there is always a fold, but it may be very inconspicuous. From here the sides are either parallel for a short distance or expand laterally at the tip. The ends of the tubes, when viewed from the side, slant down from above (*not* up, as stated in Fluke's description of *divisus*), so that from above most of the spiracular plate is visible. From the flat surface of each plate four, irregularly rugose interspiracular nodules protrude. The spiracles themselves are straight, simple slits on low carinae. The circular plates are large and well developed; their dorsal inner sector is bordered by a thickened rim which extends downward as a low ridge for a short distance beyond the ring (Fig. 54).

The rectal gills are peculiarly broad and flattened (Fig. 52).

"Metasyrphus" emarginatus (Say) and *"Metasyrphus" weborgi*
(Fluke) = (*Xanthogramma divisa* Williston)

The egg and larva of "*M.*" *emarginatus* have been described briefly and the puparium, posterior respiratory process, and spiracular plates figured by Fluke (1931). He also gives a table comparing the measurements of the various dimensions of the posterior respiratory process for *emarginatus*, *weborgi*, and *divisus*. A second table is given for the spiracular angles of these species. None of these careful measurements afford very satisfactory means of separating *emarginatus* from *weborgi*. In the Illinois region, however, *emarginatus* is by far the most abundant of the four known species of "*Metasyrphus*." The stages of "*M.*" *weborgi*, which had not been named at that time, were described in detail and figured by Metcalf (1917) as *divisa* Williston.

Larva (Fig. 50).—Average length of mature larva, 10.5 mm., width from tip to tip of lateral lobes, 5-5.5 mm., height, 1.3 mm. The color pattern is made up of seven main oblique diagonal bands of buff, pinkish tan, or orange globules on each side of the midline. Where the globules are lacking, the color is a translucent brown or greenish grey. The diagonals meet opposite one another in a point and give the larva a distinctly chevroned appearance with the points of the chevrons directed forward.

Along the midline runs a longitudinal, segmentally fragmented, more opaque stripe. As the mature larva becomes dormant the color turns dull brown to ashy grey.

For details of body form and external structures, reference should be made to the foregoing general description. The posterior respiratory process (Fig. 57) arises from a broad base and tapers distally to a distinct midfold, from where it slightly expands to the spiracular plates. The interspiracular nodules are quite variable; in some specimens they are low and rugose, while in others they have irregular perpendicular lamellae arising from the surface.

In the tables of Fluke, the two species, *emarginatus* and *weborgi*, differ in measurements of the dimensions of the posterior respiratory process by only a few hundredths of a millimeter, a difference which is insufficient for satisfactory identification by this means. The angles of the posterior spiracles also correspond very closely. The angle at which spiracle III inclines to the midline is 23° in *emarginatus* and only 12° in *weborgi*. This difference would appear to the naked eye, as the two lower spiracles are slightly more convergent in *emarginatus* than in *weborgi*.

Puparium.—Length, 8 mm., width, 4 mm., height, 3 mm., at anterior end. The shape of the puparium is considerably different from that of the larva. The anterior end arches up in a strong convex curve, rounding in front and about as broad as the width of the posterior end of the body. At about the mid-point the dorsum curves sharply down, and it is almost concave just before it reaches the base of the posterior respiratory process. The sides are almost parallel and retain, on the curving lateral line, the shrivelled remnants of the lateral lobes of the larva (Fig. 51). The posterior respiratory process is similar to that of the larva.

Food Habits.—"Metasyrphus" *emarginatus*: on *Macrosiphum rudbeckiae* (Fitch) on wild golden-rod, on *Macrosiphum ambrosiae* on wild lettuce, on *Clavigerus smithiae* on willow, and on *Aphis gossypii* on Althea or Rose of Sharon. Fluke, in Wisconsin, also records this species from *Amphorophora rubicola* on wild raspberry.

"Metasyrphus" *weborgi* has not been reared by the writer to an adult but may be represented in the above collections. Metcalf (1917), in Maine, found it among *Clavigerus smithiae* on willow, and he also gives other records from Maine as on *Aphis cerasifoliae* Fitch on choke cherry, on *Aphis cornifoliae* on dogwood, and on *Chaitophorus populicola* on poplar.

"Metasyrphus" divinus (Williston)

The immature stages of "*Metasyrphus*" *divinus* are described in detail by Fluke (1931), and in the same paper the larva, the puparium, the posterior respiratory process from the side, and the posterior spiracular

plates are also figured. The following account is taken from his description, but the illustrations have been drawn from pupal material kindly loaned to the writer by Dr. Fluke. The *divisa* described by Metcalf has been referred by Dr. C. L. Fluke to the species *weborgi* Fluke and is discussed under that species.

Larva.—Length contracted, 7 mm., width, at the widest point, 4 mm. The larva presents all the morphological details mentioned in the general description.

The larva is described as being an unusually handsome syrphid. The color pattern is, briefly, a rich reddish tan chevron occupying the median half of the body, the two ends of the body yellow. The detailed description is as follows: A tan band which occupies the posterior half of the body, oblique in shape, pointed anteriorly on about the middle segment. On this segment the tan color occupies only the middle area or disc, and the sides are yellow. The following three segments are pink, the last of the three being only irregularly tan on the dorsum. The anterior three exposed segments are yellow, and the posterior two are also yellow.

The posterior respiratory process (Fig. 53) is longer and more slender than is usual in this group. When viewed from above, it is broad at the base, slopes evenly to the middle; the sides are then parallel for a short distance, widening very slightly just before the tip. When viewed from the sides, the tip of the tube slants down from above, the dorsal side being shorter. The measurements of the dorsal and ventral sides have been reversed in Fluke's description but, corrected, they are as follows: dorsal length, 0.744 mm., ventral length, 0.896 mm., height at tip, 0.193 mm. The spiracular plates (Fig. 54) are very small, only about three-quarters of the size of those of the other three species.

Recognition Characters.—1. Small larvae, 7-8 mm. long. 2. Predominant color yellow, with rosy-tan transverse band across the middle of the body. 3. Straight, slender, tapering posterior respiratory process, the tip smallest; each spiracular plate, not more than 0.2 mm. in diameter (about three-fourths the diameter of those of the other species) (Figs. 53, 54).

Puparium.—Length, 6 mm., width, slightly under 3 mm. The colors of the larva disappear completely; the puparium is light buff or straw color with irregular black crossbars on the third to the sixth segments; the eighth and ninth segments usually with small median black dots. The shape of the puparium is similar to that of the members of this genus. The features of the posterior respiratory process are the same as those of the larva.

Food Habits.—The larva of this species has been taken on *Chaitophorus populicola* on *Populus* spp. near Columbus and Madison, Wisconsin, by Dr. C. L. Fluke.

"Metasyrphus" invigor (Curran)
(= *Syrphus felix* Fluke)

So far as known there is no previous account of the larva of this species. Fluke (1931) states only: "A careful study of the larva, pupa and posterior respiratory appendage shows very little, if any, difference between *felix* and *emarginatus*."

Larva.—Length of mature larva, 10.5 mm., width, 4.5 mm. The general description of a larva of the *emarginatus* group applies to this larva. It is slightly more slender than *emarginatus* larvae.

The color pattern in the second and early third instar larvae consists of seven pale green diagonals of scattered subcutaneous fat granules on a translucent, brown background similar to those in *emarginatus*. Along the mid-dorsum runs a pair of green opaque stripes, constricted segmentally. In the late third instar, the median stripes become bright butter yellow, tinged laterally with paler yellow; the diagonals become golden tan to white and the intermediate spaces are light translucent brown. The general effect is warm golden buff.

The posterior respiratory process (Fig. 59) affords the only characters by which this species may be separated from *emarginatus*. When viewed from above, the posterior respiratory process arises from a broad base of the same width as that in *emarginatus*, tapers inward distally to about the middle fold where the sides are parallel or slightly convex, and in the distal fourth, flares abruptly outward again so that the tips are approximately as broad as the base. This somewhat dumbbell-like, symmetrical outline is especially evident from above. A line through spiracle II is at right angles to a line through centers of I and III, while in *emarginatus* the angle between I and II is distinctly larger than that between II and III (Figs. 55, 58). The interspiracular nodules are relatively larger than those of *emarginatus* and not so high as most in *emarginatus*.

Recognition Characters.—1. Fairly large larvae, 10.5 mm. in length, tends to be green or yellow in color. 2. Posterior respiratory appendage strongly flaring at outer end which is of about the same width as the base (Fig. 59). 3. Spiracle II at right angles to a line drawn through spiracles I and III (Fig. 55).

Puparium.—Length, 8 mm., width, 4 mm., greatest height, 3 mm. The puparium is marked in the usual manner for this group with four irregular, transverse blackish bands on the anterior half of the dorsum, with a median small dot of black on segments nine, ten, and eleven (Fig. 51). The puparium has the same flaring spiracles, when viewed from above, as found in the larva.

Food Habits.—The larva has been found among *Macrosiphum ambrosiae* on wild lettuce (*Lactuca* sp.) and on *Verbasina helianthoides*,

and among *Macrosiphum sanborni* on chrysanthemum. In comparison with *emarginatus*, it is never very abundant.

EPISTROPHE Walker

Epistrophe is a large genus, containing forty-eight species according to the recent revision by Dr. C. L. Fluke (1935). The genus, however, occurs more commonly in the far West than in the Middle West. As far as the writer knows, the two species here described are the only ones of which the larvae are known.

The larvae of this genus are aphidophagous and bear a strong resemblance to the larvae of a closely related group, the *emarginatus* group of "*Metasyrphus*." However, they can be distinguished from this group, which is the only other genus with which *Epistrophe* might be confused, by the following generic characters: the shape of the body is an elongate oblong, not a broadly ovate leaf-like form (Fig. 60); the lateral serrations are plumply rounded papillae on three slightly different levels, not flat plates on a single, sharp-edged plane; the posterior spiracular plates (Fig. 64) each bear four short, delicate, interspiracular setae, a character known elsewhere only in the genus *Pipiza*; there may be a strong spur at the inner dorsal angle of the posterior spiracular plate, which is not found in the *emarginatus* group.

KEY TO SPECIES OF EPISTROPHE

- Brown and white lacy color pattern with median white chain-like marking;
dorsal spur of posterior spiracular plate claw-like; circular plates nearly circular.....*cinctus*
- Anterior third bright tan, maroon, or black, posterior two-thirds chalky white,
resembling a bird dropping; dorsal spur an elongate ridge, not a sharp
claw; circular plates elongate dorso-ventrad, irregular in outline.*triangulifer*

Epistrophe cinctus (Fallén)

The larva of this species is one of the most beautiful syrphid larvae the writer has seen. Eight larvae were found in the Wabash River valley, near Lafayette, Indiana, in the tightly curled leaves of elm infested with *Georgiaphis ulmi*. Collected on June 12, the larvae fed and reached maturity in about a week, then lapsed into a dormant state. Four were placed out of doors in a flowerpot; they remained in the larval stage until March 24, when one pupariated and emerged, an adult female, on April 4. The remainder either died or were killed by predaceous mites.

Larva (Fig. 60).—Length, 10.5-13 mm., width, 3-3.25 mm., height, 2-2.5 mm. Dorso-ventrally flattened, an elongate oblong from above, tapering gradually at the anterior end. The margin is serrated with lobe-like projections in groups of three of different sizes, the largest one slightly above and caudad to the smaller two. Each projection bears a

segmental spine (Fig. 63). These spines are minute, pale, and consist of a stout basal segment, somewhat longer than broad, surmounted by an acuminate distal segment, subequal in length to the basal one. The integument is without vestiture, delicate and finely papillose.

The general color effect is that of a lacy pattern of white, rich red-brown, and black. The colors are due, as in many other groups, to subcutaneous visceral globules. The dorsal blood vessel is separated into a chain of five, sometimes six, black oval dots (Fig. 60). Around all but the last is a keyhole-like ring of white. The margins of the lateral lobes are white and this is extended forward in diagonal bars. Between the white regions are irregular mottled areas of white, rich pink, or orange on a background of translucent dark brown. Just within the white diagonal bars is a region of deeper brown.

The posterior respiratory process (Fig. 61) is 0.7-0.8 mm. in length; about two-thirds the distance from the base is a permanent fold. Up to this point the tubes are completely fused and covered with coarse nodules; the smooth, polished distal third is less completely fused. The two tubes of this portion are separated by a groove and a deep median incision. The spiracular plates (Fig. 64) bear four delicate short interspiracular setae, each less than half the length of the spiracles. The spiracles are curved, simple slits borne on well developed carinae. At the dorsal, inner angle of each spiracular plate is a strong, claw-like spur which varies somewhat in length. The point of the spur curves outward and is hollow at its base; the base partially surrounds the circular plates which are tilted up at an angle from the surface of the posterior spiracular plate.

Puparium (Figs. 66, 68).—Length, 8 mm., height at anterior end, 2.5 mm., width, 2.5 mm. Strongly arched anteriorly, but very narrow, so that the lateral margins, when viewed from above are nearly parallel. The whole puparium has a curiously attenuated, hump-backed appearance. There is a broad ridge on the posterior two-thirds. The prominent lateral serrations of the larva have shrunk to oblique corrugations and irregular lateral tags.

The color is light brown. Since this larva pupariates in the soil, the puparium is more or less covered with earth. On the anterior third of the dorsum is an elaborate and symmetrical pattern of black spots. At the highest point of the arched region is a short, median stripe surrounded by a regular group of six smaller spots; posterior to this is a broad, gracefully shaped spot with two scroll-like arms anteriorly and a slender, posterior stem.

The characters of the posterior respiratory process are the same as those of the larva (Figs. 61, 64).

Food Habits.—This species was reared from *Georgiaphis ulmi* on slippery elm (*Ulmus fulva*).

Epistrophe triangulifer Zetterstedt

The larvae of this species were first described and figured by Metcalf (1917) under the name of *Syrphus oronoensis*. In 1922, Jones gave a colored illustration of a larva and puparium as *Syrphus triangulifer* (?) but gave no description. The figure may possibly be of this species.

The writer has not reared this species. The descriptions below are taken from Metcalf (1917), but the figures were drawn from material loaned by Dr. Metcalf.

Larva.—Length, about 11 mm., width, 2.5-3.5 mm., height, 1.5-2.5 mm. The larva is elongate in outline, flattened, subtriangular in cross sections. It resembles in all gross details those of *E. cinctus*.

Conspicuously colored, the posterior two-thirds is chalky white, except along the margins; the anterior third, the entire lateral margins and the terminal segments are bright tan, maroon, or even black. This sharp contrast gives to the larva an appearance suggestive of a bird-dropping. The chalky white median line of adipose tissue ends abruptly between segments 6 and 7 where the body is always quite blackish in larvae of all stages. On the anterior part of segment 7, the white adipose mass begins again, quite as abruptly, with two U-shaped loops opening caudad and separated by the black heart line.

The brown posterior respiratory process (Fig. 83) resembles that of *cinctus*, in length, distal constriction and surface texture but the spiracular plates are different. The black dorsal spiracular spur is elongate dorso-ventrad and ridge-like, somewhat crescent-shaped, bending laterally over the circular plate. The latter is elongate dorso-ventrad and narrower at the ventral end (Fig. 60).

Puparium.—Length, 7 mm. or more, width, 3.25 mm., height, 2.75 mm. The anterior half is irregularly globose, the puparium somewhat suddenly depressed about mid-length, the posterior half remaining flattened, much as in the larva. The predominating color of the puparium is maroon to black, extensively mottled with patches of white or pinkish brown. The writer believes this to be the color in newly transformed puparia but, from the colors of empty puparia, believes the puparium in later stages more closely approaches the colors given for *cinctus*.

Food Habits.—Metcalf in Maine (1917) records the larvae from *Pterocomma smithiae* Monell on willow, *Myzus cerasi* on cherry and on *Phorodon humuli* Schrank and *Rhopalosiphum nymphae* (Linn.) on plum. Jones (1922) reared this species from *Chaitophorus populifolii* Oestlund.

PIPIZA Fallén

The larvae of *Pipiza* are all small to medium-sized larvae, 5-12 mm. long, when mature. They are deeply wrinkled, ventrally flattened, dor-

sally convex and a long oval in outline, tapering at both ends, with a conspicuous, slender, stem-like posterior respiratory process. There are one or more pairs of short, blunt, fleshy lobes on each side of the last segment (Figs. 69, 72).

The color of *Pipiza* larvae is usually somewhat drab and indefinite and masked by the grey, waxy secretion of the aphids on which they feed. The larva of *Pipiza pisticoidea* is yellowish, flesh color, or dun; the larva of *P. femoralis* is clear, light, translucent green fading to translucent mud-color.

In addition to the general appearance, which is sufficiently distinctive to permit recognition of the genus, the larvae of *Pipiza* have some characteristic microscopic characters. The posterior spiracular plates bear four strong interspiracular sciae always more than half as long as the spiracles; there are no dorsal spines between the spiracular plates (Fig. 70).

The larvae of *Pipiza* are aphidophagous and seem to prefer as hosts those colonies of aphids which secrete a waxy flocculation. *P. pisticoidea* has been reared from colonies of *Eriosoma lanigerum* (Haus.), the woolly apple aphid, both above and below the ground. Walsh (1869) reared *P. radicum* from the root-infesting colonies of the same aphid. *P. femoralis* has been reared by the writer from colonies of *Georgiaphis ulmi*, an aphid of slippery elm, which produces flocculent white masses, and Metcalf (1913) reared it from *Colopha ulmicola* (Fitch) the coxcomb gall of elm which also secretes a waxy dust. The author has also some specimens of an unknown *Pipiza* from Rhode Island collected by Mr. John D. Crawford on *Prociphilus tessellata* (Fitch) which is also a woolly aphid, on alder. It seems rather remarkable that all the known species of *Pipiza* should prefer so uniformly aphids with waxy secretions. The habit undoubtedly affords them considerable protection; buried among the waxy masses of their hosts and dusted with the same material, it is very difficult to detect the syrphid among the colony of aphids.

KEY TO SPECIES OF PIPIZA

- Larger larvae (9-11 mm.), usually greenish in color with one pair of fleshy papillae extending back from the posterior segment; posterior spiracular plate more angular with oval circular plates; segmental spines with distal segment placed eccentrically on basal segment (Figs. 69, 71, 76). *femoralis*
- Smaller larvae (6-8 mm.), usually yellowish or dun or dull flesh color, with more than one pair of fleshy papillae on posterior segment..... 1
1. With two pairs of lateral, blunt, fleshy papillae on posterior segment; posterior spiracular plate compact, rounded, not angular, with circular plates perfectly circular; segmental spines not eccentric (Figs. 70, 72, 73)..... *pisticoidea*
 - With three pairs of lateral fleshy papillae on posterior segments..... *radicum*

Pipiza pistioides Williston

The larva and puparium of *Pipiza pistioides* have been described and illustrated by Metcalf (1916).

Larva (Fig. 72).—Length, 9 mm., width, 2 mm., height, 1.75 mm. The color of the larva varies from pale straw yellow or flesh color to dull tan and is masked by grey waxy bloom. It is transversely wrinkled and, even though heavily dusted with wax, appears bare to the naked eye. The entire integument is densely covered with very short pale thorn-like setae. It is of the typical shape of the genus, though somewhat slender and tapering at both ends. The last segment, when viewed from above, bears two blunt fleshy lobes on each side of the posterior respiratory process. The segmental spines are composed of two subequal segments, the terminal segment arising from the center of the broad basal one (Fig. 73).

The posterior respiratory process (Fig. 70) is constricted slightly at its mid-point; distad of the constriction it is polished brown, proximad it is fleshy, beset with spines and the same color as the body of the larva. The process is about three times as long as its width. The spiracles are raised on moderate carinae and on either side of each spiracle is a short, strong bristle; in all, four pairs.

Puparium.—Length, 5 mm., width, 2 mm., height, 1.8 mm. Color, dull dust brown to ashy grey. Strongly convex dorsally and somewhat concave on the ventral surface. The vestiture of the skin is not visible to the naked eye but gives a rough, felted appearance to the surface when magnified. The two pairs of fleshy lobes of the anal segment remain after pupariation as distinct lateral nodules, and the characters of the spiracular plates are the same as those of the larva. The shrunken and distorted segmental spines, however, are not sufficiently distinct to be of value in distinguishing the puparia.

Food Habits.—The larvae of *Pipiza pistioides* have been taken, so far as is known, on *Eriosoma lanigerum* (Haus.) only. They have been taken both in the colonies infesting roots and in those in the old pruning scars of apple trees.

Pipiza femoralis Loew

This larva has been described as the "cock's-comb-gall syrphus fly" by Metcalf (1913b) who describes the larva, and figures the anterior and posterior ends of the larva and the posterior spiracular plates. He did not succeed in getting it to pupariate.

Larva (Fig. 69).—Length, 11 mm., width, 2.5 mm., height, 2 mm. It is a deeply wrinkled larva, apparently bare, although the dorsum is actually covered with closely-set, pale, integumental setae. The color of the larva is clear, pale, lettuce-green. Metcalf describes his cock's-comb-gall syrphid larva as vinaceous pink or purplish. Both the color and the vestiture are obscured by a dense powdery bloom from the aphids. No dorsal blood vessel is visible, but the black or yellow abdominal contents sometimes show through the delicate integument. When the larva ceases feeding for pupariation, it becomes more and more brownish, and, at last, dull translucent mud-brown. The posterior spiracles are rich brown.

The larva tapers gently at both ends. Segments 6-11 are of nearly the same width, the fifth and anterior segments tapering to a sharp point; the twelfth segment again is narrower than those preceding it. The mouth parts are of the usual aphidophagous type with two heavy lateral mouthhooks. Two delicate antennae are visible from above on the first segment. The anterior respiratory processes are rose or brown and unusually large and prominent.

Each segment bears twelve inconspicuous segmental spines, each two-segmented, bearing on a broad basal segment a slender acuminate terminal segment. The two segments are of varying proportions on different regions of the body, but in every spine the slender distal portion is more anterior than the axis of the basal portion, giving the entire spine an eccentric or offset appearance. At the posterior end of the larva, a single blunt fleshy process from the twelfth segment extends caudad, parallel to the posterior respiratory process. Although the anterior spine-bearing papilla of *P. pisticoides* is represented in *femoralis* by a spine, the papilla is reduced or wanting.

The respiratory process is 0.75-0.8 mm. long and about three times as long as broad. The two tubes are fused completely for their entire length except for a deep median incision between the posterior spiracular plates. The whole process is hardened and darkly colored and bears on the proximal half a number of small sharp papillae. The spiracular carinae are much higher than those of *pisticoides*, and protrude over the edge of the plate, giving it an angular outline (Fig. 71). Four strong setae, about three-fourths as long as the spiracles are found, one on each side of a spiracle. The circular plates are prominent, and are dorso-ventrally oval in shape. Above the circular plates are two or more rough nodules, the only irregularities on the smooth angular plates. The rectal gills are simple and finger-like, two pairs of two.

Puparium (Fig. 67).—Length, 8 mm., width at broadest point, 3 mm.,

height, 2.5 mm. Color, dull opaque mud-brown to ashy grey; strongly convex with hollow ventral surface. The vestiture is raised on end by the contraction of the integument and gives a rough felted appearance obscured by dirt particles. Remnants of the deep segmental wrinkles are still prominent at the posterior end of the puparium; the anal lobes are much contracted and reduced. The characters of the posterior respiratory process and larger size serve to distinguish this species from other known members of the genus.

Food Habits.—The larvae have been taken on *Georgiaphis ulmi* on slippery elm (*Ulmus fulva*) and, by Metcalf, on *Colopha ulmicola* (Fitch), the cock's-comb-gall aphid of elm.

Pipiza radicum Walsh and Riley

The larva and puparium of *Pipiza radicum* were described by Walsh (1869) more than sixty-five years ago, accompanied by a small crude sketch of these and the adult. The description does not serve to distinguish this species from the more recently described species of the genus. The figure, however, shows that the larva, and possibly the puparium, has three pairs of fleshy lobes on the posterior segment. This may serve as a distinguishing feature.

Walsh's description is quoted as follows:

"Larva: Dull, pale, flesh color, tinged with yellow. Attenuated and somewhat depressed anteriorly; more blunt posteriorly, the anal segment being furnished with an elevated tube which is of a light polished brown at extremity. Wrinkled transversely, with a prominent fold at anterior and posterior edge of each segment. The larger segments well defined, the smaller ones less so. First segment thoroughly retractile, and sufficiently translucent when extended to show the dark triple-jointed mouth. A few soft, fleshy spines, of the same color as the body, and especially distinct on the anal segments. Generally covered and disguised by the soil which it inhabits. Length when extended, 0.23 inch (6 mm.). Described from two specimens taken in 1866 and three in 1868.

"Pupa: Dull, dirty yellow. Gradually formed by contraction of the larva, during which time the wrinkles are obliterated, and at last becomes quite smooth. Length, 0.18 inch (4 mm.)." Walsh also describes the creeping of the puparia of *Pipiza radicum* which, after being buried in moist sand, crawled up out of it to a distance of two inches.

Food Habits.—Predaceous on *Eriosoma lanigerum*, the woolly apple aphid, on the roots of apple, according to Walsh (1896).

PARAGUS Latreille

The mature larvae of the genus *Paragus* are very small, never over 10 mm. long, and even to the naked eye, markedly spiny.

There are three species in the United States, *Paragus angustifrons*, *P. bicolor*, and *P. tibialis*. The first species is doubted by some authors to exist at all and accepted by others on the basis of differences in the male genitalia from those of *tibialis* with which it is confused. The present writer has never reared any adults of *P. angustifrons* nor seen any larvae sufficiently distinct from those of *tibialis* and *bicolor* to be possible larvae of this species. Only one specimen of *angustifrons*, a male, has been taken in the field. It is probably rare in Illinois. The writer has seen no account of the larva in the literature.

So far as known, *Paragus* is entirely aphidophagous; the two species, *bicolor* and *tibialis*, are fairly common as red-brown, longitudinally banded or pearly white, minute larvae, inconspicuous among the axils of aphid-infested flower-heads of evening primrose, curly dock, and ironweed or among the young leaf buds of milkweed from July to September. *P. bicolor* is not so common as *tibialis* and is most abundant somewhat earlier in the season.

KEY TO SPECIES OF PARAGUS

- Posterior respiratory process broader than long; segmental spines awl-shaped;
body form broad, somewhat flattened (Figs. 74, 78, 81).....*bicolor*
Posterior respiratory process longer than broad; segmental spines blunt, peg-
like; body form slender, tapering gently at both ends (Figs. 75, 79, 82).....*tibialis*

Paragus bicolor Fabricius

The larva and puparium of *Paragus bicolor* has been described in detail and figured by Metcalf (1911b) and a briefer description has been given in "The Syrphidae of Ohio" (1913b). The larva is also described by Jones (1922) and mentioned briefly by Campbell and Davidson (1924).

Larva (Fig. 78).—The mature larva is from 7-8 mm. long, 2.5 mm. wide and 1.8 mm. high; it is conspicuously flattened dorso-ventrally. The color is quite variable. The whole larva may be dun or translucent yellowish without any visible pattern but the pulsating dorsal blood vessel. Or, it may be a white-margined larva with a broad chestnut band running longitudinally down the dorsum. The band may fade out to pale rose or to a scattered collection of dull orange dots.

The segmental spines are raised on fleshy processes. The distal segment of each is a pointed awl-shaped spine as long as the raised process, and in this species it is directed caudad on each segment (Fig. 81). The whole surface of the skin is covered with fine bead-like papillation and completely bare of vestiture.

The posterior respiratory process is broader than long and deep brown in color. Its spiracles are raised on high carinae and the dorsal spur is large and sharp (Fig. 74).

The rectal gills are simple, two-branched, Y-shaped structures as in other aphidophagous syrphids.

Puparium.—The larva usually pupariates upon the plant, among the flower spikes or under the leaves. Length, 5.5 mm., width, 2.5 mm., height, 2.2 mm. Pale to medium brown and a long nearly perfect oval from above. The remnants of the pointed larval segmental spines cover it with scattered spines. The posterior respiratory process resembles that of the larva.

Food Habits.—The larva has been taken on *Aphis rumicis* on curly dock (*Rumex crispus*), sour dock (*Rumex obtusifolius*) and burdock (*Arctium minus*), and on *Aphis gossypii* on cucumber. Jones (1922) records it from *Aphis avenae* and *Aphis helianthi*. He also reared it in the laboratory successfully on *Aphis pomi*, *Aphis carbocolor*, and *Periphyllus negundinis*.

Paragus tibialis Fallén

The larva and puparium of *Paragus tibialis* were described fully by Metcalf (1911b) and redescribed briefly in "The Syrphidae of Ohio" (1913b). Campbell and Davidson (1924) give a brief description and a drawing of the larva, which does not show much structural detail.

Larva (Fig. 79).—The mature larva of *Paragus tibialis* is slightly smaller than that of *P. bicolor*, averaging 6-7 mm. long, 2 mm. wide, and 1.8 mm. high. The color is even more variable. It may range from pure, translucent pearly-white without any markings whatever to a beautiful, rich red-brown, banded form, the broad, median brick-red band edged with black and flanked by yellow lateral regions. There are all gradations between these: yellowish white larvae with two lateral, brown streaks on the anterior third, larvae with the two anterior brown streaks enclosing a faint pink mottling, pinkish white larvae with a broad orange-dotted band, dun-colored larvae with a brown, broad, median band. There is a distinct, but delicate, dorsal blood vessel.

The larva is more slender, spindle-shaped and not as flattened as that of *bicolor*. The integument, like that of *bicolor* is bare with a beady surface. The segmental spines are also raised on a fleshy projection, but are not quite so long as those of *bicolor*. The outer segment is a short blunt peg only about one-third as long as the entire process, and not directed backward except on the last three body segments (Fig. 79).

The brown posterior respiratory process is longer than broad and bears spiracles raised on high carinae and a sharp dorsal spur (Fig. 75). The rectal gills are similar to those in *bicolor*.

Puparium (Fig. 77).—Length, 5 mm., width, 2.5 mm., height, 2.5 mm. The color varies from light yellow to deep, dull brown. The form is more plumply stream-lined than that of *P. bicolor* and can be readily distinguished by its round tear-drop shape. The character of a posterior respiratory process which is longer than broad, is also present in the puparium.

Food Habits.—The larvae of *P. tibialis* have been taken among colonies of *Aphis rumicis* on curly dock, *Aphis vernoniae* Thomas on iron weed (*Vernonia baldwini*), *Aphis coreopsidis* Thomas on Spanish needle, *Aphis oestlundii* on evening primrose, *Aphis gossypii* on cucumber, and on *Myzocallis asclepiadis* Monell on common milkweed.

Metcalf (1913b) records this larva as taken from burdock preying on an unidentified aphid, and Campbell and Davidson (1924) in California report it from *Aphis gossypii* and *Aphis maidis*.

DIDEA Macquart

The larva of only one species of *Didea* has been so far described. This larva is found, in the Midwest, with the individuals of one characteristic host aphid on which it is predaceous, the large, mottled purplish-grey *Longistigma caryae* (Harris) on sycamore, late in September and October. Their very occurrence in the colony of these extraordinarily large aphids (one-fourth inch in diameter) and their own large size is so characteristic that it almost certainly serves to identify them as the larvae of *Didea*. Only one other larva, and a much smaller syrphid, *Syrphus torvus*, is known to attack this aphid. This fly is not very numerous in Illinois.

Didea fasciata Macquart var. *fuscipes* Loew

The larva and puparium of this species has been fully described by Metcalf (1911a), and again in 1913 in "The Syrphidae of Ohio" and more briefly in "The Syrphidae of Maine" (1916).

Larva (Fig. 84).—The fully matured larva of *Didea fasciata fuscipes* is 15 mm. long, 5-6 mm. wide at its broadest point, and 3.5 mm. high. It is broad, flattened, and blunt at the posterior end, and tapered scarcely at all at the anterior end. It has a very shaggy, spiny appearance, due to the fact that it is ornamented with segmental fleshy pointed lobes, some of which are accented in black and others in yellow, although its segmental spines are actually very weak and slender. The tough, wrinkled integument is closely set with sharp, black, short setae. At the tip of each fleshy process is a slender, weak spine, only about twice as long as the surrounding setae (Fig. 80). The ventral side is flat and completely bare of spinules.

The color of the larva conceals it admirably in the colony of grey, black-spotted host aphids. It is, in general, a mottled greyish fawn and deep brown, accented with black and yellow. The thin dorsal blood vessel, the tips of the median segmental lobes, the entire small dorsal lobes, and some irregular diagonal bands on the sides and dorsum are black. The bases of the median lobes, the dorso-ventral, lateral, and ventro-lateral lobes are tipped with bright yellow. The ventral sole is a broad band of translucent lavender, probably due to the internal contents colored by the purplish body juices of the aphids.

The large, short, disc-like posterior respiratory process (Fig. 83) is deep red-brown, with pale tan margins around the spiracular slits. The whole spiracular plate has a rough frilled appearance because the surfaces between the spiracles are raised in one or more undulating perpendicular lamellae, resulting in a corrugated surface much like that on the shell of a black walnut.

The rectal gills are four, arising in two simple pairs as in the genus *Syrphus*.

Puparium.—Length, 9-10 mm., width, 4.5 mm., height, 4.5 mm.; neatly rounded in front and nearly circular in cross section, tapering down to the posterior segment where it flattens out laterally. It is covered with conspicuous papilla-like prominences. The color is rich golden brown, dusky on the curved sides due to the investiture of black setae, and speckled down the length of the dorsum by four regular rows of black dots, the remnants of segmental lobes. The puparium can also be identified readily by two well preserved larval features: the weak, slender segmental spines and the short, disc-like, frilled, posterior spiracles.

Food Habits.—In Illinois, by the writer, and in Ohio, by Metcalf, *Didea fasciata fuscipes* has been taken only among colonies of *Longistigma caryae* on sycamore and basswood. In Maine, however, Metcalf (1916) reported it as occurring at the last of July and first of August on *Plocamaphis flocculosa* (Weed), the willow grove plant louse.

BACCHA Fabricius

The larvae of *Baccha*, so far as known, are aphidophagous or feed on other Homoptera. Bhatia (1932) reared *Baccha pulchraformis* Austen in India from psyllid nymphs on the leaves of *Bombax malabaricum*.

Baccha clavata Fabricius

The larva of *Baccha clavata* has been very briefly described and figured by Campbell and Davidson (1924) but not sufficiently carefully to show its most characteristic features. The larva and puparium are

very crudely figured by J. R. Watson (1926) but not described. The puparium was described by Townsend (1897), but the description is inadequate for identification.

Larva (Fig. 85).—Length, 10-11 mm., width, 2.5 mm., height, 2.5 mm. The larva of *Baccha clavata* is a cylindrical, very beautiful larva with soft-tones, dull colors, and with very large, thick, segmental spines on high narrow folds of the integument, separated into distinct dorsal nodules.

The general effect is that of soft greenish-grey lateral regions with a broad, pink dorsal stripe accented on each side by broken narrow black edges. The dorsal nodules may be soft pink or opaque white. The colors of the dorsal band may vary from greyish white to pale brown.

The larva appears to the naked eye distinctly but sparsely spined, in contrast to the very spiny larvae of *Paragus* and *Didea*. The large segmental spines are two-segmented. The distal segment fusiform and about twice as long as the proximal segments (Fig. 89). The median spines of the posterior segment project back prominently over the posterior spiracular process. In addition to the dorsal and lateral rows of segmental spines, there are short ventral spines on the three segments behind the anterior spiracles. The surface of the skin is covered with a fine mass of very short, indistinct setae.

The posterior respiratory process (Figs. 87, 88, 90) is short, dark brown, smooth and polished and set rather deeply in the folds of the last segment. It is so truncated as to expose the spiracles to the ventral surface more than to the posterior surface as in other syrphid larvae. There is no dorsal spine but a smooth rounded surface. The rectal gills are a simple pair of two-branched gills similar to those in *Syrphus*.

Puparium (Figs. 86, 91).—Length, 5.5-6 mm., width, 2.5 mm., height, 2.5 mm. of a long oval shape. It often, though not always, retains a characteristic foliate pattern of light tan, outlined in deep brown. The constricted remnants of the light dorsal band of the larva are tan, the black border is retained as an undulating brown margin. In addition, the posterior spiracles are the same as those of the larva, and shrivelled remnants of the distinctive two-segmented spines can always be found on some part of the puparium.

Food Habits.—The larva has been taken on *Aphis gossypii* on muskmelon and cucumber, on *Aphis oestlundii* on evening primrose (*Oenothera biennis*), and on *Macrosiphum sanborni* on cultivated chrysanthemum. Campbell and Davidson (1924) record this species from *Aphis rumicis* and *A. medicaginis* Koch.

Baccha lugens Loew

J. R. Watson (1926), in connection with citrus insects in Florida, figures the larva, puparium, and adult of this species, but the drawings

are so sketchy as to give almost no characters for identification of the larva and puparium. There is no description. The drawing of the larva shows a broad bulge about one-third its length from the anterior end, and that of the puparium has a strong anterior swelling with an abrupt constriction beyond the middle. Nothing can be distinguished as to the spines or posterior spiracles.

In June, 1936, Mr. B.D. Burks of the Illinois Natural History Survey collected a puparium at Urbana, Illinois, and reared from it an adult of *Baccha lugens*. This puparium is curiously dilated anteriorly and agrees in general appearance with that figured by Watson. From this single specimen the description which follows has been made.

Puparium (Fig. 92).—Length, 5 mm., width, 2 mm., height, 2 mm. The rather delicate, light golden integument is strongly dilated anteriorly and from above appears smoothly clavate. In lateral view, however, the dilation drops posteriorly in an abrupt hump about mid-length, giving a unique outline to the puparium. There are no remnants whatever of the intersegmental spines of the larva which are probably quite small, judging from the smoothness of the integument. The posterior spiracular plates (Fig. 93) show a strong relationship to those of *Baccha clavata*, but do not slant ventrally quite so strongly as the plates of that species. As in *clavata* a dorsal spine is absent from the posterior spiracular plates. The two lower pairs of spiracles are crowded ventrally as in *clavata* but are more vertical in position than those of *clavata*.

Food Habits.—The food of this species in Illinois is not known, but it is probably aphidophagous. In Florida it is recorded from *Aphis spiraeicola* Patch and *Aphis gossypii* Glover on citrus trees.

CHRYSOTOXUM Meigen

The writer has not seen any specimen belonging to this genus but the structural characteristics given below point to the probability that the larva may be of the aphidophagous habit. The descriptions given below are taken from those of C. T. Greene (1923a). The larva was found under a stone in a moist situation. The species given below is taken rarely in Illinois.

Chrysotoxum pubescens Loew

Larva.—Length, 11 mm., width, 5 mm., nearly cylindrical. Opaque white, segmentation irregular with numerous transverse wrinkles. The cephalic end tapers very slightly. On the ventral surface are seven pairs of prolegs. The posterior respiratory process, located in the center of the caudal end is .5 mm. long, dark reddish to black, and the two tubes are separated by a longitudinal groove on the dorsal and ventral surfaces.

Puparium (Fig. 94).—Length, 8 mm., width, 4 mm., posterior respiratory process, 0.75 mm. Pale, dull, luteous yellow. The puparium is cylindrical, rather blunt on the cephalic end, gradually tapering down to the caudal end. The integument is microscopically rugose. There is no evidence of either anterior or pupal spiracles.

The posterior respiratory process (Fig. 95) is about as long as high. The spiracles are three sinuous slits on low, shining black carinae; the dorsal spur is a circular ridge which gives the appearance of a tube-like structure on the upper inner angle of the spiracular plate. The interspiracular nodules are triangular, raised, and have a finely granular surface.

The food habits are unknown.

XANTHOGRAMMA Schiner

Xanthogramma flavipes Loew

Vimmer (1933) figures crudely the empty puparium of a Czechoslovakian species of *Xanthogramma*. The outline of the puparium is very similar to that of *Xanthogramma flavipes*. He describes it briefly in his key (translated): "Bearers of posterior stigmata short, black-brown, shiny, pointing obliquely, ends rounded. Pupa pear-shaped, slightly constricted in the middle." He does not designate the species and gives no further details except a subsequent note: "Length, 7 mm., width, 3 mm."

The single specimen reared was found as a short-bodied, white, soft-skinned larva, on July 18th, lying on leaf mold at the immediate foot of a tall walnut tree in a woods near Urbana. The situation in which it was found gave no evidence of its food material. The larva was seeking a place for pupariation; it was inactive, with its mouth parts and anterior segments retracted; it transformed two days later and emerged on July 31. The morphologic characters show a somewhat intermediate condition between the aphidophagous and the saprophagous types. There is no evidence of pupal horns, but the posterior spiracles show the elaborate form so characteristic of saprophytic types.

Larva.—Length, 8 mm., width, 3.3 mm., height, 3 mm. Color, dull, opaque white. The larva is of a short sausage-like shape, nearly cylindrical and rounded fully at both ends. The exterior is almost without features; the integument smooth and without vestiture, the form extremely simple. Numerous parallel creases divide the surface into about 32 sub-equal annulets, usually three to each actual segment.

The antennae and mouth parts were invisible, the mouth opening minute and inconspicuous. The anterior spiracular processes are just visible as minute light brown cornicles near the anterior curve of the body.

Internally the mouth hooks are small and weak; there are low pharyngeal ridges of the type found in saprophagous larvae.

The posterior respiratory process (Fig. 97) is polished, shining red-brown, about as long as it is high at the tip. The two tubes are completely fused into a short truncate cone, broad at the base, somewhat narrower at the tip, and oval in cross section. The tip is smoothly rounded at the edges and bears on its face three pairs of tortuously looped spiracles, three pairs of minute interspiracular nodules and two small circular plates, near the mid-region, which are faintly granular on the surface. At the dorsal margin is a raised, V-shaped ridge with the point just above the circular plates and the two arms diverging laterally over the rounded surface of the plate, where they diminish and disappear.

Puparium (Fig. 96).—The puparium is almost the same in general shape and dimensions as described above for the larva. Color, light golden brown with brownish creases and with a silky sheen due to minute shagreen on the surface. The middle region of the puparium is slightly constricted. The ventral surface shows a slight concavity, and there is an inconspicuous hip-like ridge at the posterior end on the ventral third of each side.

Food Habits.—Nothing is known of the food habits of this larva. Vimmer (1933) says "In ant hills." It is probably saprophytic.

XYLOTA Meigen

One or more of the immature stages of several species of this genus are known. Johnson (1906) described briefly and figured the larva and puparium of *Xylota pigra*. The larvae of two unknown American species of *Xylota* are described by Johannsen (1935), but the rather rare immature stages of this genus have been most frequently taken as puparia and most descriptions of known species are of this stage. Greene (1923a) has described the puparia of *X. bicolor* and *X. pigra* and illustrated them in detail. These descriptions appear in a briefer form in Johannsen's "Aquatic Diptera, Part II" (1935).

Two pairs of dark, heavy, lateral hooks fused at their bases appear to be characteristic of this genus although Lundbeck (1916) describes an European species, *X. segnis*, in which the hooks are replaced by groups of small spines. The hooks are always located on the dorsal aspect of the false head in the larva and at the antero-ventral angle below the edge of the operculum in the puparium. The posterior respiratory process is usually only moderately long, from twice to about four times the width of the process, and there is always more or less of a lattice-like sculpturation present on its distal portion.

KEY TO SPECIES OF XYLOTA

- Posterior respiratory process shorter, only about three times as long as height, with a marked constriction midway in length; plumose hairs at tip lacking (Fig. 98).....*X. pigra*
- Posterior respiratory process longer, at least four times as long as high, no marked constriction, plumose hairs present (Fig. 101)..... 1
1. Larger species (12 mm.) with two pairs of posterior lateral fleshy processes.....*X. bicolor*
- Smaller species (under 10 mm.) with three pairs of posterior lateral fleshy processes..... 2
2. Posterior respiratory process rugose for more than half its length distally; inner thorn short, blunt, and straight; outer thorn curved (Fig. 100); larger (8 mm.).....*X. nemorum*
- Posterior respiratory process rugose for half or less than half its length; thorns subequal, both curved (Fig. 99); smaller (7 mm.).....*X. fraudulosa*

Xylota fraudulosa Loew

A puparium from which this description has been made, was collected by Mr. A. P. Arnason on a decayed log at Tiptonville, Tennessee. Adults of this species, collected in Illinois, are represented in the Illinois Natural History Survey collection.

Puparium (Fig. 101).—Length, 7 mm., width, 2.75 mm., height, 2 mm. The color is yellowish brown with overlying chaffy vestiture of a whitish color. The puparium is slightly flattened dorso-ventrally; it declines steeply in front, and is dorsally arched posteriorly giving a curiously mouse-like outline. On each side of the rather pointed antero-ventral margin, somewhat obscured by the chaffy vestiture, is a pair of subequal black, basally fused hooks or lateral thorns, both of which are curved (Fig. 99). They are situated just below the operculum and remain even if the operculum is lost. Mediad and just dorsad of these are the short brown, peg-like anterior spiracular processes on the lower piece of the operculum. On the dorsal piece of the operculum are the pupal respiratory horns which are yellow, curved, club-like and about three times as long as broad. On the distal portion of each are five double rows of more or less confluent tubercles, except for a narrow area on the inner anterior surface. On the ventral surface of the body, six paired groups of recurved hooklets can be plainly seen, the remnants of the prolegs; the seventh and most anterior pair is no longer discernible in the strong rugosity of the anterior end.

The posterior respiratory process is 1.25 mm. in length, light brown, slender, with a slightly bulb-like expansion just before the tip. The distal half, or a little less, is sculptured with lattice-like depressions. There are long plumose hairs present on the posterior spiracular plates, which resemble those illustrated for *Xylota nemorum* (Fig. 104).

Xylota nemorum Fabricius

The larvae and puparia of this introduced species were described by Lundbeck (1916) from Denmark, and his description of the larva has been used here; the figures were drawn from four puparia in the collection of the Illinois State Natural History Survey which were collected at White Heath, Illinois.

Larva.—Length, 9 mm. The color is yellow or whitish yellow. The body is elongated, arched above and a little flattened below; the head is broad and blunt; the posterior end is somewhat attenuated. The body is transversely corrugated and bears toward the end of the tapering posterior part at each side three lateral processes, clothed in relatively long hairs. On the ventral side are six pairs of prolegs armed with spines, and below the prothoracic segment is a pair of similar spined warts. At each side of the prothoracic segment outward from the brown anterior spiracles is a large black double hook, the outer hook being curved and larger.

The brown respiratory process is 0.7-1 mm. long. In this species the distal portion is clathrately sculptured for more than half its length. The posterior spiracular plates (Fig. 104) are partially separated by a dorso-ventral median constriction and bear at their margin a pair of dorsal and a pair of short lateral denticles giving the process a somewhat stellate appearance. The palmate hairs are long.

Puparium (Fig. 102).—Length, about 9 mm. Color brownish, rather arched, front end turning downward. The puparium has the same lateral thorns, the same posterior lateral fleshy processes, somewhat shrivelled, and the same posterior respiratory process as the larva. On the upper piece of the operculum or at the posterior border of the inclined anterior region are two yellow pupal respiratory processes, curved backward and outward and beset with small tubercles arranged in double ring-like rows.

Food Habits.—The Illinois specimens bear no food record, but Lundbeck (1916) records this species from the "decaying, humid stub of a beech" and also from the "water in a tree-stub."

Xylota pigra Fabricius

The larval description is that of Johnson (1906); the pupal description and Fig. 98 have been made from two puparia loaned by Dr. C. L. Fluke.

Larva.—Length, 14 mm. The color is dirty yellow or brownish with ten or eleven ill-defined, rugosely wrinkled segments, covered with short hairs, which are somewhat longer on the sides. The first segment is armed on each side with a pair of black thorns, the posterior one curved backward (Fig. 98); the posterior portion bears three pairs of large, hairy

processes, and terminates with a prominent, shiny brown respiratory tube, showing slight annulations on the middle.

Puparium (Fig. 98).—Length, 10-11 mm., width, 4.5 mm., height, 3.5 mm. The color is rich yellowish brown, slightly shining. The body is of the same general shape as that of *X. nemorum*, but arched strongly in the mid-region and sloping more gradually cephalad. The body surface is covered with a fine, rough chaffy pubescence, and the remnants of larval wrinkles remain as short, narrow, transverse folds on the dorsal surface. The segmental spines are three-branched and still quite prominent, especially along the lateral line. The three lateral processes of the posterior segments of the larva are still present and bear numerous long setae.

The lateral thorns are black and, as in other genera, just below the ventral edge of the operculum. The anterior respiratory processes of the larva remain, on the lower edge of the operculum. These are short, yellow-brown cylinders about as long as their diameter and cut off obliquely at the tip. On this oblique elliptical area are nine yellow rays radiating from a central region to the margin; they are illustrated by Greene (1923a). The pupal thoracic horns are bright yellow and located on the upper portion of the operculum. They appear to be indistinguishable from those of *X. fraudulosa* and *X. nemorum*.

The posterior respiratory process is shorter than those of other known species of *Xylota* and bears a marked constriction at the mid-point in its length, beyond which the process is pitted but before which it is smooth and polished. The long plumose hairs on the tip of the process in other species appear to be lacking.

Food Habits.—The puparia from the collection of Dr. C. L. Fluke were obtained from larvae taken under the bark of *Pinus ponderosa* by P. M. Scheffer at Union Flats, Wisconsin. Johnson (1906) gives "beneath the bark of pine logs. It frequented the wet bark near the ground where there was more or less fermentation of the sappy portions of the wood." Greene (1923a) records it as collected under the bark of *Pinus ponderosa* at Larkspur, Colorado.

Xylota bicolor Loew

The following is a brief account taken from the description of the puparium by Greene (1923a).

Puparium.—Length, 12 mm., diameter, 4 mm., cylindrical; dull deep luteous yellow with a brownish tinge, with yellow pubescence. There are two pairs of lateral fleshy processes on the posterior body segments, the cephalic pair smaller.

At the cephalic end and slightly above the lateral edge is a pair of reddish chitinous hooks fused at their base. The larger, or inner, one

curves backward, and the outer one curves out and backward. The larval anterior respiratory processes are yellowish-brown with six finger-like radiating areas on the oblique surface. The pupal respiratory horns are approximately four times as long as wide, reddish-yellow and tuberculated on the distal three-fourths.

Food Habits.—Greene (1923a) records this larva from the frass in a pocket of an old tulip tree, *Liriodendron tulipifera*.

TEMNOSTOMA St. Fargeau and Serville

The larvae of the genus *Temnostoma* are wood-boring syrphids, inhabiting wet, partially decayed logs in moist woodlands. Clean-cut galleries are made with powerful thoracic rakes by means of contractions of the anterior segments. In 1933, Metcalf described in detail the larvae of two species which occurred in a group of more than a hundred in a rotten log in the vicinity of Winnetka, Illinois. However, they are rather rare in this region. Both species in this account are widely distributed in the United States.

The genus can be recognized at a glance by a nearly cylindrical, blunt-ended, elongate body-form and by a delicate, milk-white integument with three dark appendages, two at the anterior extremity and one at the posterior extremity (Fig. 105). The anterior two are the prothoracic rakes, strong, heavily toothed structures, bearing at their base the anterior spiracular plates. The unpaired appendage is the posterior respiratory process. The puparium bears short, perforated thoracic horns in addition to these, as do other saprophytic syrphids, such as *Xylota*.

The following descriptions have been adapted from Metcalf (1933). The figures of the posterior spiracular plates, and of the larva and puparium are drawn from material loaned by Dr. Metcalf.

KEY TO SPECIES OF TEMNOSTOMA

- Posterior spiracular plate fused along dorsal fourth, with a prominent, sharp dorsally curved tooth at each lateral margin (Fig. 107); prothoracic rakes heavier with seven or eight teeth in each of the three rows.....*bombylans*
- Posterior spiracular plate completely but narrowly separated by a shallow groove with numerous transverse folds; eight or more blunt, low teeth distributed around each lateral margin (Fig. 106); prothoracic rakes lighter, with usually five teeth on the inner row, six in the middle row, and seven in the outer row.....*balyras*

Temnostoma bombylans Fabricius

Larva (Fig. 105).—Length, 12 mm., width, 3.5 mm., height, 3.5 mm. The larva is milk-white, except for the prothoracic rakes, the adjacent

spiracles, and the posterior respiratory process. There are eight principal body segments, each with several transverse wrinkles and of nearly equal size, besides those of reduced size at the extremities. The head segments are directed ventrad, the inconspicuous mouth parts and rudimentary antennae lying about 1 mm. back on the ventral side. The prothoracic rakes thus lie at the anterior extremity. The rakes measure 0.5 mm. to 1 mm. across and are separated by about twice their width. Each is made up of seven or eight teeth in each of three rows. Segmental spines are present in the usual positions, but are extremely minute. At the middle of the somewhat truncate caudal extremity arises the posterior respiratory process, which is elevated less than half a millimeter; its diameter is about 1 mm.

The drawings of the posterior spiracular plates of both *Temnostoma bombylans* and *Temnostoma balyras* have been accidentally inverted in Metcalf's drawings and the terms used in his descriptions are also inverted. The following description is with corrections of this error. The posterior spiracular plates (Fig. 107) are fused along the dorsal fourth with an overhanging median tooth at the center of the dorsal margin. In addition to this tooth are two others, one prominent, upturned marginal tooth on each lateral margin, dorsal to the second palmate hair. The second palmate hair on each side is much more prominent, erect and stouter than the other three. The numerous slit-like spiracles are longer than those of *T. balyras*, their chitinous expansions averaging seven to each spiracle.

Puparium (Fig. 108).—Length, 10.5 mm., width, 3.5 mm., height, 3.5 mm. The integument becomes parchment-like and yellowish-tan, shrinking somewhat, posteriorly, so that the puparium is of greater diameter at the anterior end. The anterior extremity is an oblique, flat, thickened, blackish plate, nearly circular in outline, which lies flush with the surface of the burrow, forming a little circular plug. On the plate are, dorsally, the two pupal respiratory horns and, at the extreme ventral margin, the two thoracic rakes and the former larval anterior spiracular plates. The pupal respiratory horns are slightly more than half a millimeter long by about one-third millimeter in diameter, polished brown, nearly cylindrical, bluntly rounded at the apex and dotted with minute respiratory apertures. These seem to be very similar in the two species. The posterior end is also thicker and has, for a region around the posterior respiratory process, a hardened, shiny, scaly texture and is deep tan or brown, much darker than the rest of the integument. The posterior respiratory process remains the same as in the larvae, and all of the above characters may be used to separate the puparia of the two species.

Temnostoma balyras (Walker)

Larva (Fig. 106).—In superficial appearance, the larva of *Temnostoma balyras* is similar to that of *Temnostoma bombylans*. The actual differences between the two species are found mainly in the characters of the thoracic rakes, and posterior respiratory process. The differences, pointed out by Metcalf, are as follows: Posterior spiracular plates (Fig. 106) completely but narrowly separated by a shallow groove with numerous transverse folds; no dorsal median tooth. Each plate with eight equivalent, blunt marginal teeth, a pair adjacent to each of the four interspiracular palmate hairs. All the palmate hairs of equal size. The slit-like spiracles shorter than those of *T. bombylans*; the circular plates, smaller. The prothoracic rakes are lighter, the teeth usually being five in the inner row, six in the middle row, and six or seven in the outer row.

Puparium.—The puparium is strongly similar to that of *Temnostoma bombylans* in appearance and dimensions. However, the characters of its posterior respiratory process and thoracic rakes are like those of the larva, and the puparium can be readily distinguished from that of *Temnostoma bombylans*.

Food Habits.—Metcalf (1933) reared both from a moist, decaying, but still firm, hard-maple log. He cites the instances of larvae of this genus being reared from a water-soaked willow log in Pennsylvania and by H. S. Barber from a decaying hickory log near Washington, D. C.

MERODON Meigen

The only representative of this genus in the United States is *Merodon equestris* Fabr., the large narcissus fly or the daffodil fly. Like its companions in habit, *Eumerus* spp., it is an introduction within the last twenty years from Europe. It is now established in the bulb-growing regions of the United States. Only one specimen, a larva collected by Dr. T. H. Frison at Canton in 1925 and now in the collection of the Illinois State Natural History Survey collection, has been recorded from Illinois. Though the preferred host plant of the larvae is narcissus, they have been recorded from many genera of the lily family. Unlike *Eumerus*, there is only one generation a year. The winter is passed in the bulbs as full-grown larvae. In March and April, the larvae leave the bulbs, usually through the neck, and pupariate in the soil about half an inch below the surface. The pupal period is unusually long for a syrphid, 35 to 40 days. The flies emerge in April and May and lay their eggs in the soil around the base of the bulbs. The newly hatched larvae usually burrow through the basal plate of the bulbs. The center of the bulb is hollowed out; the

cavity soon becomes largely filled with decaying matter and excrement of the consistency and color of peanut butter. Bulbs are usually so far consumed that they will not grow, and when they do grow they produce only weak yellowed leaf growth, but no bloom. The larvae sometimes migrate from one bulb to another, if the food is exhausted in the first. Hodson (1932b) says that the larvae pass through four instars. They are full grown by fall.

Merodon equestris Fabricius

Since *Merodon equestris* has become a major pest to the bulb-growing industry it has been described frequently in the literature, but since its habits and large size make it easy to recognize it is usually described only with the barest brevity. Childs (1914) gives three very brief descriptions and photographs *in situ* of the larva and adult; Essig (1926) gives another brief description of larva and puparium and also illustrates with photographs. Wilcox and Mote (1927) give a brief description and illustrate with photographs of egg, larva, puparium, and injury. Wilcox (1927) gives a very similar account with a figure of an adult. The best account is by Hodson (1932b) in connection with a bionomic study, but much is omitted from his descriptions. He figures first instar and fourth instar larvae and gives photographs of egg, puparium, and adults.

The descriptions given below and the drawings have been made from material from Sumner, Washington, given to the writer by Mr. Randall Latta.

Larva (Fig. 109).—Mature larva, 15-19 mm. long, 4-6 mm. wide, 4-5.5 mm. high. The larva is bent into a strong curve, the body very roundly arched on the dorsum and slightly flattened on the ventral side, but not conspicuously broader than high. The color is dirty yellowish or light yellowish-brown.

The sausage-like body is plainly divided into segments and tapers little before the rounded ends. On the posterior segment is a pair of minute fleshy papillae, lateral and ventral to the posterior respiratory process. Each bears a simple long segmental spine and a tuft of body spinules. The entire surface of the integument is covered with an even pile of minute spinules. The segmental spines are long and conspicuous and consist of a tapering needle-like terminal segment, eight times as long as it is wide at the base, on a wide thick basal segment about four times as wide as the terminal segment.

The anterior segments are corrugated with conspicuous folds forming a false head. The mouth hooks and antennae are large and conspicuous. The anterior spiracles are short, brown, cylindrical projections on the dorsal side of the false head. On the dorsum of the second segment

behind the anterior spiracular processes are two swollen oval areas, the sites of the future pupal respiratory horns. There are no conspicuous ventral prolegs, and ventral tufts of setae are lacking.

The posterior respiratory process is a shining, coal-black, short, truncated, oval tube about as long as it is wide. Completely around its base runs a constriction, cutting off a basal rim; from here the completely fused tube tapers with a series of parallel rugose folds to the smooth rim of the spiracular plate (Fig. 109). The spiracular plate (Fig. 112) is a smooth plane with two sunken broadly reniform depressions in the center; these are the circular plates. The spiracles are three pairs of elaborately looped slits without denticles, flat with the surface. On the edges of the plate are four pairs of minute groups of branched hairs. The ventral side of the respiratory process bears a groove of varying depth.

Rectal gills were not found in this species.

Puparium (Fig. 111).—Length, 13 mm., width, 5.5 mm., height, 5.5 mm. Tough and leathery, dark brown to black in color, but may be reddish. The puparium is not curved as in the larva, but is nearly straight on the ventral side, higher on the anterior end, and sloping evenly to the rounded posterior end. It is circular in cross section at any point. The lateral papillae of the larva persist in much the same size as before but the spines are reduced. The integumental spinules form a rough, felted surface, much wrinkled toward the posterior end. In the middle of the upper half of the operculum on each side are the curved, horn-like pupal respiratory processes, which, according to Hodson, are not extruded until the eighth to tenth day after pupariation. Its surface is perforated with minute circular apertures. The small larval anterior spiracular processes still persist on the lower half of the operculum. The black, glossy posterior spiracular process is similar to that of the larva.

Food Habits.—The preferred host is narcissus. In addition Hodson (1932b) lists hyacinth and tulip rarely, *Amaryllis*, *Habranthus*, *Vellota*, *Eurycles*, *Galtonia*, *Leucojum*, *Galanthus*, the wild snowdrop of England, and *Scilla nutans*, the wild hyacinth, all members of Liliaceae. Essig (1926) lists in addition *Hippeastrum*.

EUMERUS Meigen

The flies of the genus *Eumerus* are known as the lesser bulb flies or lunate onion flies. Three species occur in the United States, all of which have been introduced with importations of bulbs from Europe. From the first introduction of this genus into the United States, which appears to have been in 1904, when a single specimen was collected by a Dr. Fletcher at Ottawa, Canada, it has spread rapidly in the East and on the Pacific coast. It has probably been repeatedly introduced in shipments of bulbs from Holland, France, and England. The lesser bulb fly was always

assumed to be *Eumerus strigatus* Fallén. But in 1920, J. E. Collin called attention to the fact that another very similar species, *tuberculatus* Rondani, was far more numerous in England than *strigatus*. C. H. Curran found, when he examined the specimens in the Canadian National Museum, that all previous reports of *strigatus* were actually *tuberculatus*. There has been much confusion in the records in the United States as well, since for many years the damage caused by the lesser bulb fly was always attributed to *strigatus*. In 1927 another species, *narcissi*, was distinguished by Leslie M. Smith in California from narcissus bulbs imported from France. Latta and Cole (1933) describe the adults of these three species and give tables of characters distinguishing between them.

Larvae of *Eumerus strigatus* from Centralia, Illinois, are in the University of Illinois collection. *Eumerus tuberculatus* is rare in Illinois, but there are thirteen adults from two localities in the state in the State Natural History Survey collection. *E. narcissi* is found in France and, in America, only in California. The larvae of *Eumerus* have been recorded, in addition to many kinds of bulbs, from manure (Hodson, 1931), but in this, they do not reach complete development. In Java, the larva of *Eumerus parallelus* has been found in the liquid of the leaf axils of *Colocasia indica*. The larva is figured by Sack (1931); it differs markedly from the bulb-feeding species of *Eumerus*. Although the adults of the bulb-feeding species show a marked preference for diseased or injured bulbs in egg-laying, there is no doubt that the larvae are truly phytophagous. The eggs are laid on the soil near a bulb or on the dried foliage. According to Wilcox (1926) the newly hatched larvae enter the bulb at the base or neck, but Hodson (1927) states that the young larvae crawl down into the bulb neck, where there is a small amount of damp and rotting tissue meeting the living neck. They begin feeding here and so enlarge the rotted area, gradually working down into the heart of the bulb, which becomes slimy and decayed. From then on, fresh living tissues are torn down and reduced, partly by the salivary juices, to a state of liquifaction so that the interior of the bulb soon becomes a slimy, excrementitious mass. Puparium occurs in a dry place, either on the shrivelled foliage or in the adjacent soil. The lesser bulb fly usually has two generations a year.

The larvae are all small to medium-sized (7-12 mm.), dirty white or brownish, subcylindrical maggots with a prominent brick-red posterior respiratory tube. A characteristic group of four fleshy processes is found on each side of the posterior segment; a large dorsal papilla, two small twin papillae in the middle position and a still larger ventral papilla, which extends out on each side of the respiratory process. The segmental spines are double and the whole integument covered with short spines. The larvae of *Eumerus* are most likely to be confused with the larvae of *Syrirta pipiens*.

KEY TO SPECIES OF EUMERUS

- Mandibular sclerites larger, with usually seven prominent teeth, rarely less than six (Fig. 114); groove between antennal tubercles is shallow or absent (Fig. 116).....*strigatus*
- Mandibular sclerites smaller, with less numerous teeth, usually five prominent pairs, occasionally six (Fig. 110); groove between antennae pronounced (Fig. 115).....*tuberculatus*
- (For other characters see comparison under *tuberculatus*)

Eumerus strigatus Fallén

The egg, larva, puparium, and injury were described by Wilcox (1926) and illustrated by photographs, and by a figure of the puparium. Essig (1926) describes the stages of this fly very briefly and gives other photographs of the larvae, puparium, and injury. Another account of the life history of *Eumerus strigatus* is given in 1927 by Wilcox illustrated with new photographs. Keifer (1930) gives a brief description of the larva but no figures. Hodson (1931) made a detailed study of *Eumerus strigatus* and *tuberculatus* and compared them, but this author, like all the previous authors, neither studied nor figured the segmental spines or posterior respiratory process.

The descriptions given below, and the figures, have been made from specimens kindly sent by Mr. Randall Latta of Sumner, Washington, and from others collected at Centralia, Illinois.

Larva (Fig. 113).—Mature larvae are from 8-10 mm. long, 2.5 mm. wide, and 1.8 mm. high. The living larvae, according to Wilcox (1927), are usually a dirty greenish-grey but may vary from white to reddish. The wrinkled body is compactly rounded and somewhat flattened ventrally with three short papillae and one rather long papilla on each side of the last segment. The characteristic arrangement is a large, short, dorsal papilla, a twin tubercle in a median position of two very small, short papillae, and a longer ventral projection that extends outward from the posterior angle of the last segment, almost or as long as the respiratory tube. The papillae terminate in a cluster of three or four curved spines.

The integument is covered with rows of little tubercles, which are the basal papillae of the segmental spines. The segmental spines (Fig. 119) are remarkable in that they consist of a pair of curved terminal spines on a single broad basal piece. On the fleshy papillae the spines are three or four to a basal piece. The entire dorsum is covered with closely set but unevenly distributed spinules. They are longest and most dense on the ridges and little tubercles of each body segment.

On the anterior end protrude the prominent antennae, two pale, rounded, fleshy tubercles, each surmounted by two small papillae (Fig. 116). In this species the groove between the tubercles is shallow, or

absent. The mouth hooks are broad, heavy toothed structures with a variable number of denticles, but according to Hodson (1932) always with more than six and usually seven large denticles on each mandibular sclerite (Fig. 114). The anterior spiracular processes are inconspicuous light brown projections.

The posterior respiratory process (Fig. 127) is a single, smooth, straight, polished tube, tapering slightly to the evenly rounded ends with the two component tubes completely united into one. It is only about twice as long as its width at the tip. The spiracular plates bear, in a central depression, two circular plates and on a flat, crescentic ridge are borne three roughly cogwheel-like spiracles. At the margin of each plate are four tufts of branched, fringing hairs (Fig. 122).

The rectal gills consist of a pair of three-fingered structures, the mesal finger shorter than the outer two (Fig. 125).

Puparium (Fig. 123).—Length, 6-8 mm., 3 mm. wide, 2.8 mm. high. The color according to Wilcox (1927) is light, dirty grey, but may be brown to red. The surface is rough, due to the presence of numerous minute spinules and retains the fleshy papillae of the larva in somewhat shrunken condition. The front of the puparium is evenly rounded but somewhat narrowed, and the posterior end tapers into the prominent smooth tube of the posterior process. The ventral outline is almost perfectly straight. On the anterior end, faint whitish lines indicate the future operculum and its central line of cleavage. On the upper section of the operculum are found the prominent pupal respiratory horns which are not visible in the freshly formed puparia, but are extruded later. They are slightly curved, brown, tapering structures with minute circular apertures on small nodules (Fig. 120). On the lower section of the operculum, the larval anterior spiracles are still visible. The posterior respiratory plates are the same as in the larva (Fig. 122).

Food Habits.—With the possibility of some confusion with *tuberculatus* the larva has been recorded attacking narcissus, hyacinth, tulip, amaryllis, iris, shallots, onion, parsnip, potato, carrots, and rotting grapefruit (Keifer, 1930).

Eumerus tuberculatus Rondani

In 1920, Collin pointed out that in England lesser bulb flies believed to be *E. strigatus* were in reality *tuberculatus*, which was much more abundant there. This indicates how similar the two species are and in what probable confusion many of the American records and descriptions may be. Collin gives in this paper a description of the larvae of *tuberculatus* and *strigatus*, but they are not differentiated. Hodson (1927), in a

bionomic paper, gives brief descriptions and photographs of the egg, larva, and puparium of *tuberculatus*. In 1931, Hodson again gives a description of *tuberculatus* comparing it with *Syrirta pipiens* and figures for each the larva, larval mouth hooks, and puparium. In 1932a, the same author published a comparison of the larvae of *E. strigatus* and *E. tuberculatus* in an attempt to find key characters, but even with this study it is not always possible to determine a single specimen with certainty. Hodson's key is quoted below.

Larva.—The larva of *E. strigatus* is so similar to that of *E. tuberculatus*, that the description need not be repeated. According to Hodson the chief differences between the two species are as follows, the most important being the first two:

	<i>E. strigatus</i>	<i>E. tuberculatus</i>
Mandibular sclerites....	Larger, teeth more numerous, usually 7 prominent pairs, rarely less than 6 (Fig. 114).	Smaller, teeth less numerous, usually 5 prominent pairs, very occasionally 6 (Fig. 110).
Antennae.....	Groove between tubercles bearing antennae shallow or absent (Fig. 116).	Groove pronounced (Fig. 115).
Anterior spiracles.....	Color darker.	Color lighter.
Posterior spiracular process.....	Shorter, wider, color darker.	Longer, narrower, color lighter.
Minute scattered spines.....	Darker, less abundant.	Lighter, more abundant.
Larger (segmental) spines.....	Darker, shorter.	Lighter, longer.
Anal processes.....	Appreciably darker than remainder of integument.	Unicolorous with or only slightly darker than remainder of integument.

Puparium.—The puparium cannot be differentiated from that of *E. strigatus* unless dissected for the mandibular sclerites.

Food Habits.—The food habits are the same as for *strigatus*.

SYRITTA St. Fargeau and Serville

The only species of this genus in North America is the common and cosmopolitan *Syrirta pipiens*, which occurs throughout the world according to Sack (1931). The larva is a short-tailed slime dweller, breeding usually in the manure of animals. A species in Sumatra, *Syrirta capitata*, lives in the fluid of a pitcher plant, *Nepenthe tobaica* (Sack, 1931).

Syritta pipiens Linnaeus

The immature stages of *Syritta pipiens* have been described in detail and figured by Metcalf (1916). The rectal gills, posterior spiracles, and cross section of the pharynx are figured by Krüger (1926) who gives an exhaustive morphological account of the larva. Hodson (1931) describes the larva and puparium of *Syritta pipiens* in comparison with those of *Eumerus tuberculatus* and figures the cephalopharyngeal skeleton, larva, and puparium of both. Johannsen (1935) describes again the larva and puparium of *Syritta pipiens*, using the descriptions of Metcalf and the figures of Metcalf and Krüger.

In the description that follows, the account has been taken from those of Metcalf and Hodson. The larva has been redrawn from Hodson, the pupal respiratory horn, the posterior fleshy processes, and posterior spiracular plates from Metcalf, and the rectal gills from Krüger. The puparium was drawn from a specimen loaned by Dr. C. L. Fluke.

Larva (Fig. 117).—Length, 10 mm., width, 2.75 mm., height, 2 mm. The larva is broadly fusiform, tapering moderately toward the false head and more narrowly at the posterior end, and broadest from segments five to nine. The color is dirty yellowish and the entire body is covered with pale and delicate, close-set microscopic hairs, which are longer on the more exposed portions. The body bears, just anterior to the posterior respiratory process, three pairs of pointed fleshy projections (Fig. 128).

The anterior segments are differentiated into a false head with about a dozen longitudinal furrows. The anterior spiracles are very dorsal in position, located between the first and second furrow from the midline and are sessile, each with apparently three rounded nodules on its summit. The head has a transverse band of microscopic hooklets above the mouth. There are seven pairs of prolegs; each proleg has about two dozen hooklets of varying sizes. On segments eleven and twelve are the conspicuous lateral processes, the anterior, shortest one on the eleventh, the middle and posterior ones, which are progressively longer, on the twelfth. They are covered with spinelets, which are longer toward the tip.

The posterior respiratory process is a brown, chitinized polished tube, about 0.75 mm. long (Fig. 128). It is straight, tapering, and very slender, about five times as long as its width at the tip. The tubes are semi-transparent, permitting the large tracheal trunks to be seen throughout its length. The posterior spiracular plates (Fig. 118) have centrally located circular plates and three pairs of contorted spiracles which are ornamented around the edge with from nine to fourteen lateral projections or denticles which are irregular in size and irregularly shaped. The plates are each surrounded by four tufts of feathered hairs.

According to Krüger (1926) the rectal gills are twelve-branched (Fig. 124).

Recognition Characters.—1. Yellowish larvae about 10 mm. long with three pairs of posterior fleshy processes, the first shortest and the last longest (Fig. 128). 2. Seven pairs of prolegs each with two dozen hooklets of varying sizes (Fig. 117). 3. Shape of the aperture of the spiracles contorted and irregularly toothed with nine to fourteen denticles (Fig. 118). 4. Slender, straight posterior process, tapering toward the tip and five times as long as wide at the top (Fig. 128).

Puparium (Fig. 126).—Length, 6.8 mm., width, 2.95 mm., height, 2.68 mm. Elongate-ovate in outline, a little more attenuated posteriorly, nearly circular as seen from the front, a little flattened on the venter. Color yellowish white, darkening to dull muddy brown. The remnants of the three pairs of projections are still readily visible on the anal segments but the prolegs have disappeared and even the hooklets are difficult to find on the general roughened and soiled integument.

The pupal respiratory processes (Fig. 121) protrude from the upper half of the operculum as blunt, club-shaped projections. The enlarged distal half is studded with about 75 minute nodules in which are found the spiracular apertures. The posterior spiracular process is like that of the larva.

Food Habits.—The stages of *Syrpitta pipiens* have been reported from cow and horse manure, from guinea pig manure and from human excrement. It has also been found in decayed and rotting tulip bulbs and in heaps of vegetable refuse (Hodson, 1931).

BRACHYPALPUS Macquart

The larvae of this genus are short-tailed saprophytes dwelling, usually, in rotting wood. They are characterized by a carrot-shaped body, slightly flattened dorso-ventrally, and the typical features of saprophytic larvae, a false head, hooked prolegs, and posterior spiracular plates bearing palmate hairs and convoluted spiracles.

KEY TO SPECIES OF BRACHYPALPUS

- Length of posterior respiratory process about three times as long as broad;
a single heavy lateral hook on each side of false head; campaniform
pupal respiratory horns covered with numerous small cones on each of
which is a stellate spiracle (Figs. 130, 132, 134).....*frontosus*
- Length of posterior respiratory process one and a half times as long as broad;
two, closely adjacent lateral hooks on each side of false head; conical
pupal respiratory horns with numerous, but fewer, low ring-like tubercles
with a depression in the center (Figs. 131, 133).....*rileyi*

Brachypalpus frontosus Loew

The larva and puparium of this species have been described by Malloch (1915) who figured the larva, puparium, front view of head, and the pupal prothoracic thorns. The puparium was described previously by Parker (1915) very briefly; he failed to observe the lateral thorns at all.

The larva and puparium are described from specimens in the Illinois Natural History Survey collection.

Larva (Figs. 129, 134).—Length, 19 mm., width, 4 mm., height, 3.5 mm. The body color is creamy white but the posterior respiratory process is light brown deepening to reddish brown at the tip. The body is carrot-shaped, slightly flattened dorso-ventrally and deeply and regularly wrinkled. On the ventral surface the papillae of the ventro-lateral segmental bristles form a pair of prominent longitudinal, scalloped carinae. Surrounded by these are six pairs of prominent prolegs each armed with three rows of brown recurved teeth. A seventh pair, similarly armed, is located on the false head on a level with the lateral hooks.

On the anterior margin of the false head are three and a partial fourth row of small, dorsally-curved, dark brown hooks of three sizes, the largest in the most posterior row. Well posteriad of these and just laterad of the short peg-like anterior respiratory processes is a single pair of heavy, black hooks curving back and outward.

The entire integument is beset with a soft, white pile of minute but stout hairs. The segmental spines, all raised on prominent papillae are either four- or five-branched. There are three pairs of lateral processes posteriorly. The most anterior pair are mere papillae and dorsal in position. The second pair are lateral in position and about twice as long as the first, and the last pair are lateral, four times as long as the first and curved back around the last segment.

The posterior spiracular plates (Fig. 129) are typical for a saprophytic species and are at the apex of a fused respiratory process about 2 mm. in length.

Puparium (Figs. 132, 137).—Length, 14 mm., width, 4.5 mm., height, 4 mm. The color is medium burnished brown. The puparium is moderately inflated; the wrinkles and carinae of the larva, much reduced. The segmental spines and posterior processes are much shrivelled but retain the characters of those of the larvae. The six posterior prolegs remain visible as groups of strong hooklets but are hardly raised from the surface. The anterior pair are almost invisible in the great contraction of the anterior segments. The prominent pair of single lateral hooks are now at the ventral cephalic edge of the puparium, outside of the operculum and may be found even if the operculum has been lost. The pupal respiratory horns (Fig. 132) are short blunt domes, covered with

tubercles, each of which bears a stellate aperture or group of apertures at the tip. Malloch (1915) describes the pupal respiratory processes of this species as being represented only by slight callosities. The writer believes that in his specimens they had not yet been extruded. The posterior respiratory process is similar to that of the larva.

Food Habits.—The specimens described by the writer were not accompanied by collection data. Malloch (1915) records this species from under bark on a rotten tree trunk near Urbana, Illinois, and Parker (1915) recorded it from under moss on the top of a mountain range south of Hagerstown, Maryland.

Brachypalpus rileyi Williston

The only account of this species is that given by Greene (1923a) in which he describes the larva from two larvae taken at Glen Echo, Maryland, and the puparium from two puparia collected at Dead Run, Virginia. Adults of this species have been collected in Illinois. The descriptions which follow are adapted from Greene.

Larva.—Length, 9 mm., diameter, 3.5 mm., length of posterior respiratory process, 1 mm. Nearly cylindrical, with the sides about parallel, dull, light brownish-yellow. The body is transversely wrinkled and the entire surface closely set with short, fine pubescence; there are numerous small tufts of setae arranged in longitudinal rows on the dorsum. The last three segments terminate laterally in a long conical projection, each with numerous dark brown spines. These projections increase in size toward the caudal end.

At the anterior end, on each lateral edge is a small, nearly circular, reddish chitinous plate, each bearing two prongs (Fig. 131); the inner one points up and back toward the dorsum, the other points out and backward. Just above these are the elliptical, deep reddish anterior spiracles. They are about as long as their greatest diameter and are cut obliquely toward the outside; this surface is smooth with seven finger-like light areas radiating toward the inner edge.

The posterior respiratory process is 1 mm. long, heavily chitinized, deep reddish-yellow. Along the center is a vertical groove reaching to the brownish-black apex. The tip, in outline is crudely shaped like a figure 8. The circular plates are circular and near the center. There are four sinuous slits in each half and Greene's illustration shows no sign of minute chitinous denticles along the slits as in *frontosus*. It shows no palmate hairs as in *frontosus* but at the outer margin of each spiracular plate are two lateral denticles.

Puparium.—Length, 9 mm., diameter, 4.25 mm. Not so rugose as the larva; dull, dark reddish-brown with entire surface covered with a short

microscopic pubescence. At the apex are the double hooks of the larva. The pupal spiracles are reddish-black, cone-shaped, leaning slightly outward and backward. Their height is only slightly more than the diameter at the base. There are numerous tubercles on the surface; each tubercle is nearly round with a faint depression in the center. The posterior respiratory process is similar to that of the larva.

Food Habits.—The larvae were found under the bark of hickory and the puparia in a cedar stump.

TROPIDIA Meigen

The single known larva of this genus, *Tropidia quadrata* Say, possesses, on each side of the false head two heavy lateral hooks, their bases separated by a little more than their length. This seems to be the most distinctive feature of the species.

Tropidia quadrata Say

The puparium was described and figured by Malloch (1915) from specimens found floating in water near Havana, Illinois. Metcalf later (1916) described all the stages in detail and illustrated them with numerous drawings. The following descriptions and the figures have been taken from the latter author.

Larva (Fig. 138).—Length, 16 mm., width, 3.5 mm., height, 3.5 mm. The larva is dirty white or clay yellow, nearly cylindrical, the anterior segments forming a globose false head and the posterior segments tapering rapidly before the posterior respiratory process. On each side of the posterior segment are three conical fleshy protuberances.

The body surface is closely set with microscopic, pale brown, short, soft hairs. The segmental spines are three-branched. There are seven pairs of fleshy prolegs on the ventral surface, each bearing a crown of recurved hooks, the anterior ones largest.

The dorsal part of the bulbous false head bears two large lateral thorns on each side, their bases about 0.35 mm. apart. Between the thorns of each side and dorsad of them are three irregular transverse rows of smaller and various-sized thorns. Near each side and among these hooks is the sessile anterior larval spiracle bearing four rounded nodules.

The posterior respiratory process (Fig. 139) is about 0.75 mm. long and is grooved along the mid-dorsal and mid-ventral lines and truncated at the tip. The spiracles are roughly S-shaped and each ornamented with about twenty short, rounded, lateral denticles irregular in size and irregularly distributed. The palmate hairs are quite short and some are further subdivided.

Puparium (Fig. 141).—Length, 8-9 mm., width, 3.5 mm., height, 3mm. The puparium is pale brown and broadest a little in front of the middle where it is nearly circular in cross section. It is only a little narrowed and globose in front, but evenly tapered caudad to about one-third the width just in front of the posterior respiratory process.

On the dorsal transverse piece of the operculum is borne a morel-like pupal respiratory horn which bears on its distal surface a hundred or more minute papillae. The large lateral hooks are drawn forward to lie at the anterior extremity of the ventral line, outside of the operculum. The larval anterior respiratory processes are included on the operculum.

The three pairs of lateral fleshy processes, somewhat shrunken and indurated, are visible posteriorly, and the larger hooklets of the prolegs can be distinguished. The posterior respiratory process is the same as for the larva.

Food Habits.—The larva was found by Metcalf (1916) in moist, but not watery masses of human excrement and well-decayed potatoes.

BRACHYOPA Meigen

The single known larva and puparium of this genus is that of *Brachyopa vacua* O. S. which was described by Greene (1917). The larva and puparium are so similar that only the puparium was figured by him. The following brief account is taken from Greene's description.

Brachyopa vacua Osten Sacken

Larva.—Length, 8 mm., width, 3mm., nearly cylindrical. The color is dull, opaque yellow-ochre, brown, or black. The first segment is pointed; the greatest width is at the fourth segment, and it gradually decreases toward the caudal end.

The entire body is finely rugose; the dorsum very rugose transversely; in the middle of each segment is a transverse depression or groove. On the base of the first, pointed segment is a transverse row of six fleshy tubercles and on all succeeding segments, eight or ten fleshy tubercles just above the center. These bear the three- to four-branched segmental spines. In addition to the prominent tufts of segmental spines there are, at the base of the first segment, a row of small, fleshy, bristle-like projections; all other segments have three rows each of similar projections. The entire ventral surface of the larva is covered with minute, brownish-black spines.

The anterior respiratory processes are a pair of conical dark reddish-brown projections on the lateral margins of the first segment. The posterior respiratory process is nearly cylindrical, 1 mm. long, mostly dull black but shiny at the apex.

Puparium (Fig. 140).—Length, 7 mm., width, 4.75 mm., nearly cylindrical. The color is not given. The puparium is very similar to the larva except for the characters noted. In profile, the puparium slopes from about the middle of the second segment anteriorly, having a wedge-shaped appearance. The integument is much smoother than that of the larva; all the fleshy, bristle-like projections are much compressed and shrivelled.

The pupal spiracles are reddish-brown, conical, and curved outward. They bear numerous small tubercles around the sides with one at the apex.

Food Habits.—Greene (1917) records the larvae from the juice of decaying fungi under dead bark (*Liriodendron*) at Falls Church, Virginia.

VOLUCELLA Geoffroy

The larvae of *Volucella* are large, elongate, nearly bare maggots with a short, stump-like posterior respiratory process and with six, more or less elongate, fleshy tentacle-like processes of the posterior segment arranged in a semi-circle around the posterior respiratory process. In one European species, *V. inanus*, and in the North American species, *V. nigra* Greene (1923c), the fleshy processes are very short and have become mere papillae, but they are arranged in the same transverse curved row as the longer processes of other species.

The writer has no determined material of the immature stages of this genus; the drawings (Figs. 142, 145) were made from a larva collected by Dr. T. H. Frison in the nest of *Bombus fervidus* Fabr. at Baraboo, Wisconsin. There are few American species of which the immature stages have been described, but a very exhaustive account of the immature stages of several European species is given by Jules Künkel d'Herculais (1875).

The food habits of *Volucella* are of two distinct kinds. As far as known all the species in this region are scavengers in the nests of bumble bees, consuming the wastes of the nest and the dead larvae and pupae of the bees. In the Southwest the larvae of *Volucella* approach in habits the bulb flies, living in decaying cavities of cacti which are constantly enlarged by the insects. A review of the literature on food habits is given by Metcalf (1913b).

MICRODON Meigen

The remarkable sub-hemispherical larvae of *Microdon* (Fig. 143) are comparatively rare; the immature stages of only a few species have been described by entomologists. Wheeler (1910) states that these larvae have been repeatedly described as molluscs under the generic names of *Scutelligera*, *Parmula*, and *Ceratoconcha* and as Coccidae.

Although in most species there is no trace of segmentation and the segmental bristles appear to be missing, these unusual larvae do show at least one characteristic feature of Syrphidae in the presence of a fused posterior respiratory process. The details of the larva have been discussed on page 14. On pupariation, the creeping sole becomes attached to the walls of the ant galleries and the integument becomes hard, dark, and brittle, but there is little change in shape. These puparia extrude, as all the saprophytic Syrphidae, a pair of pupal respiratory horns from the upper portion of the operculum.

The writer has not had access to many specimens, and these have been of doubtful determination. The figures given (Figs. 143, 144) were drawn from a larva in the Illinois State Natural History Survey collection determined by J. R. Malloch as *Microdon globosus* Fabr., a species which, according to Wheeler, is synonymous with *M. tristis* Loew. Its appearance does not agree particularly well with Wheeler's figure of the larvae of *M. tristis* but it may be that species.

The immature stages of the following species have been described. *Microdon tristis* Loew, a reddish-brown reticulated form from the nests of *Formica schauffussi*, was described and figured by Wheeler (1908), and the puparium and posterior spiracles of the same species have been figured by Metcalf (1913b). Greene (1923a) described and figured *Microdon coarctatus* Loew, a milky-white larva covered with cone-like projections, from the nest of a small black ant, *Monomorium minutum* Buckley at Difficult Run, Virginia, and (1923b) *Microdon megalogaster* Snow, a dull brownish-red, faintly reticulated larva from the nest of *Formica fusca subsericea* Say at Falls Church, Virginia. Cole (1923) described the stages and gave a figure of the puparium of *Microdon piperi* Knab, a western species which ranges north along the Pacific Coast. The larva is bluish green with the median ridge and margins of the body brown. It inhabits the nest of *Camponotus maculatus vicinus* Mayr. In addition to these known species, the larvae of at least two other unknown American species of *Microdon* have been described by Wheeler (1901) and by Brues (1903).

The food habits of the larvae were for a long time problematical, although it was known that the larvae die when removed from association with their host ants. In 1911, however, Donisthorpe in England succeeded in showing that the larvae feed on the ejected material from the infra-buccal pockets of the ants. The fact that they are scavengers is interesting in view of the fact that, though highly modified they have retained two very typical characteristics of the saprophytic division of the syrphid larvae, the pupal respiratory horns and the elaborate posterior spiracles.

CERIOIDES Rondani

Cerioides signifera (Loew)(= *Ceria willistoni* Kahl, *Ceria signifera* Loew)

The puparium of *Cerioides signifera* (Loew) was briefly described by Banks (1903), and a puparium of *C. signifera*, which is considered by Metcalf and Curran to be a synonym of *willistoni*, was described briefly by Johnson (1893). Both descriptions are rather general. The puparium was again described by Malloch (1915) in much greater detail, and from this description the following has been taken. The figure, however, was drawn from a specimen in the Illinois Natural History Survey collection.

Puparium (Fig. 146).—Length, 14 mm., posterior respiratory process, 4 mm. Yellowish white, mottled with brown or blackish, opaque. The operculum was missing.

The dorsum is ornamented with a median longitudinal series of paired, wart-like tubercles, six pairs in all, the dorso-lateral margins each with six wart-like tubercles in a longitudinal row and slightly caudad of the corresponding sub-median one; between the sub-median and dorso-lateral warts is a longitudinal series of much smaller warts. There are four other such longitudinal rows of much smaller warts on the lateral surfaces, the medio-lateral line with a pair of small warts, the anterior of each pair white, with a small brown spot ventrad of it. The larger tubercles are armed with setulose hairs at the apices and the general body surface is covered with microscopic pale hairs.

On ventral surface of segments 1 to 4 are pairs of slightly raised circular areas crowned with dark setulose hairs; on the remaining segments are discernible circular areas but no setulose hairs. On each of the posterior two segments is a transverse series of four thorn-like processes.

The posterior respiratory process is shining brown, completely fused, transversely oval in cross section, and seven times as long as thick.

Food Habits.—The puparium was recorded from upon oak bark at Falls Church, Virginia, by Banks (1903) and from an oak leaf near Bala, Pennsylvania, by Johnson (1893). Banks states that the larva of *Cerioides* is supposed to feed in the flowing sap of trees. The known habits of the Indian species described by Bhatia (1931) bear out this statement.

APPENDIX

LIST OF KNOWN PARASITES

The parasites listed for each species are those reared by the writer unless followed by a reference to another author. The letters I, C, and F following the name of the parasite refer to Ichneumonidae, Chalcidae, and the subfamily Figitinae of the Cynipidae respectively.

SYRPHID

PARASITES

- Allograpta obliqua*.....*Diplazon laetatorius* (Fabr.) (I)
Diplazon scutellaris (Cress.) (I)
Syrphoctonus agilis (Cress.) (I)
Syrphoctonus pacificus (Cress.) (I) (Cole, 1933)
Homotropus humoralis (Prov.) (I) (Cole, 1933)
Pachyneuron allograptae Ash. (C) (Cole, 1933)
Conostigmus sp. (C) (Cole, 1933)
Bothriothorax sp. (C) (Malloch, 1915)
- Sphaerophoria cylindrica*.....*Diplazon laetatorius* (I)
Diplazon scutellaris (I)
Syrphoctonus agilis (I)
Syrphoctonus pacificus (I) (Cole, 1933)
Homotropus humoralis (I) (Cole, 1933)
Pachyneuron allograptae (C) (Cole, 1933)
Conostigmus sp. (C) (Cole, 1933)
- Mesogramma polita*.....*Zamicrotoridea syrphicola* Ash. (I)
Eupteromalus dubius (Ash.) (C)
Syrphophagus flavipes Ash. (C) (Sanderson, 1900)
Pachyneuron mesograptae Ash. (C) Sanderson, 1900)
- Eupeodes volucris*.....*Diplazon laetatorius* (I) (Campbell and Davidson, 1924)
Syrphoctonus maculifrons Cress. (I) (Campbell and Davidson, 1924)
- Lasiophthicus pyrastris*.....*Syrphoctonus maculifrons* (I) (Kamal, 1926)
Syrphoctonus pacificus (I) (Kamal, 1926)
Homotropus humoralis (I) (Kamal, 1926)
Pachyneuron allograptae (C) (Kamal, 1926)
Bothriothorax californicus How. (C) (Kamal, 1926)
Conostigmus sp. (C) (Kamal, 1926)
- Syrphus rectus*.....*Diplazon laetatorius* (I)
Zamicrotoridea syrphicola (I)
Bothriothorax peculiaris How. (C)
Pachyneuron allograptae (C)
- Syrphus ribesii-vittafrons*.....*Diplazon laetatorius* (I)
Bothriothorax peculiaris (C)
- Syrphus torvus*.....*Diplazon laetatorius* (I)
Syrphoctonus pleuralis (I)
Callaspidia provancheri Ash. (F)

SYRPHID	PARASITES
<i>Metasyrphus wiedemanni</i>	<i>Diplazon laetatorius</i> (I) <i>Syrphoctonus agilis</i> (I) <i>Bothriothorax peculiaris</i> (C) <i>Aspicera</i> sp. (F)
<i>Metasyrphus vinelandi</i>	<i>Diplazon laetatorius</i> (I) <i>Diplazon scutellaris</i> (I) <i>Syrphoctonus agilis</i> (I) <i>Aspicera</i> sp. (F)
<i>Metasyrphus perplexus</i>	<i>Diplazon laetatorius</i> (I)
<i>Metasyrphus meadii</i>	<i>Diplazon laetatorius</i> (I) (Kamal, 1926) <i>Syrphoctonus maculifrons</i> (I) (Kamal, 1926) <i>Syrphoctonus pacificus</i> (I) (Kamal, 1926) <i>Homotropus decoratus</i> (Cress.) (I) (Kamal, 1926) <i>Bothriothorax peculiaris</i> (C) (Kamal, 1926) <i>Pachyneuron allograptæ</i> (C) (Kamal, 1926) <i>Syrphophagus</i> sp. (C) (Kamal, 1926)
" <i>Metasyrphus</i> " <i>emarginatus</i>	<i>Syrphophagus smithi</i> Kamal (C) <i>Homotropus bicapilleris</i> var. <i>albopictus</i> Davis (I) (Fluke, 1931)
<i>Paragus bicolor</i>	<i>Diplazon laetatorius</i> (I)
<i>Paragus tibialis</i>	<i>Diplazon laetatorius</i> (I) <i>Pachyneuron allograptæ</i> (C) <i>Pachyneuron</i> sp. (C) (Campbell and Davidson, 1924) <i>Aspicera</i> sp. (F)
<i>Baccha clavata</i>	<i>Diplazon laetatorius</i> (I) <i>Diplazon scutellaris</i> (I) <i>Pachyneuron californicum</i> (C) (Campbell and Davidson, 1924)
<i>Eumerus strigatus</i>	<i>Rhembobius abdominalis</i> (Prov.) (I) (Cushman, 1930)
<i>Merodon equestris</i>	<i>Rhembobius abdominalis</i> (I) (Cushman, 1930)

BIBLIOGRAPHY

ALSTERBERG, GUSTAF.

1934. Beiträge zur Kenntnis der Anatomie und Biologie der limnophilen Syrphiden-larven. Biol. Zentralbt., 54:1½:1-20.

BANKS, NATHAN.

1903. Puparium of *Ceria willistoni*. Proc. Ent. Soc. Wash., 5:310.

BARBER, H. S.

1913. Notes on a wood-boring syrphid. Proc. Ent. Soc. Wash., 15:151-152.

BHATIA, H. L.

1931. Life histories of Indian Syrphidae. Ind. Jour. Ag. Sci., 1:503. 4 pls.

BHATIA, H. L., and SHAFFI, M.

1932. Life histories of Indian Syrphidae. Ind. Jour. Ag. Sci., 2:550-555. 5 pls.

BRUES, C. T.

1903. Notes on some California myrmecophiles. Ent. News, 14:148-149. 2 figs.

CAMPBELL, ROY E., and DAVIDSON, W. M.

1924. Notes on aphidophagous Syrphidae of southern California. Bul. S. Cal. Acad. Sci. (Jan.-Feb. and Mar.-Apr. issues), 23:3-9 and 59-71. 5 pls.

CHILDS, LEROY.

1914. The large narcissus bulb fly. Cal. St. Com. Hort. Mo. Bul., 3:73-76. 2 figs.

COLE, F. R.

1920. Notes on the lunate onion fly, *Eumerus strigatus*. Ent. News, 31:2:31-35. 1 fig.

1923. Notes on the early stages of the syrphid genus *Microdon*. Pomona Coll. Jour. Ent. and Zool., 15:2:19-20. 1 fig.

1933. Natural control of the citrus mealybug. Jour. Ec. Ent., 26:856-864. 1 fig.

COLLIN, J. E.

1920. *Emerus strigatus* Fallen and *E. tuberculatus* Rondani (Diptera, Syrphidae). Ent. Mo. Mag., 56:3:102-106. 1 pl.

CURRAN, C. H.

1920. Observations on the more common aphidophagous syrphid flies. Can. Ent., 15:3:53-55.

1921. New species of Syrphidae. Can. Ent., 53:8:171-176.

CUSHMAN, R. A.

1930. New species of Ichneumon flies and taxonomic notes. Proc. U. S. Nat. Mus., 76, Art. 25, No. 2822:3.

DAVIDSON, W. M.

1922. Notes on certain species of *Melanostoma*. Trans. Amer. Ent. Soc., 48:35-47. 3 figs. 1 pl.

DAVIS, J. J.

1916. *Aphidoletes meridionalis*, an important dipterous enemy of aphids. Jour. Ag. Res., 6:883-888. 1 pl. 4 figs.

DONISTHORPE, H. S. J. K.

1927. Guests of British ants; their habits and life histories. 268 pp. illustrated. Routledge and Sons, London.

ESSIG, E. O.

1926. Insects of western North America. 1,035 pp. 766 figs. MacMillan Co., New York.

FLUKE, C. L.

1929. The known predaceous and parasitic enemies of the pea aphid in North America. Wis. Ag. Exp. Sta. Res. Bul., 93:1-47. 6 pls.
1931. Notes on certain syrphus flies related to *Xanthogramma* (Diptera, Syrphidae) with descriptions of two new species. Trans. Wis. Acad. Sci. Arts and Letters, 26:289-309. 2 pls.
1933. Revision of the syrphus flies of America north of Mexico (Diptera, Syrphidae, *Syrphus* s. l.). Trans. Wis. Acad. Sci. Arts and Letters, 28:63-127. 3 pls.
1935. Revision of the *Epistrophe* flies of America north of Mexico (Diptera, Syrphidae). Entomolog. Amer., 15(n.s.):1. 3 pls.

FOLSOM, J. W.

1909. The insect pests of clover and alfalfa. Ill. Ag. Exp. Sta. Bul., 134:144-152. 2 figs.
1922. Entomology with reference to its ecological aspects. (3d ed.) pp. vi + 1-502. 5 pls. 300 figs. Blakiston's Son and Co., Philadelphia.

GÄBLER, HELLMUTH.

1932. Beitrag zur Kenntnis der *Eristalis*-larven. Stettin. ent. Zeit., 93:143-147. 5 figs.

GREENE, C. T.

1917. A contribution to the biology of North American Diptera. Proc. Ent. Soc. Wash., 19:146-161. 4 pls.
- 1923a. A contribution to the biology of North American Diptera. Proc. Ent. Soc. Wash., 25:4:82-89. 2 pls.
- 1923b. The larva and pupa of *Microdon megalogaster* Snow (Diptera). Proc. Ent. Soc. Wash., 25:5-6:140, 141. 1 fig.
- 1923c. A new species of *Volucella* (Diptera). Proc. Ent. Soc. Wash., 25:7-8:165-168. 1 pl.

HODSON, W. E. H.

1927. The bionomics of the lesser bulb flies. Bul. Ent. Res., 17:373-384. 3 pls.
1931. A comparison of the immature stages of *Eumerus tuberculatus* Rond. and *Syrphid pipens* Linn. (Syrphidae). Bul. Ent. Res., 22:55-58. 3 figs.
- 1932a. A comparison of the larvae of *Eumerus strigatus* Flin. and *E. tuberculatus*. Bul. Ent. Res., 23:247-249. 2 figs.
- 1932b. The large narcissus fly, *Merodon equestris* Fabr. (Syrphidae). Bul. Ent. Res., 23:429-448. 1 pl.

HOWARD, L. O.

1900. A contribution to the study of the fauna of human excrement. Proc. Wash. Acad. Sci., 2:597.

JOHANNSEN, O. A.

1935. Aquatic Diptera. Part II. Orthorrhapha-Brachycera and Cyclorrhapha. Cornell Ag. Exp. Sta. Mem., 177:1-62. 12 pls.

JOHNSON, C. W.

1893. Puparium of *Ceria signifera*. Ent. News, 4:91.
1906. Notes on some dipterous larvae. Psyche, 13:1-4. 1 pl.

JONES, C. R.

1922. A contribution to our knowledge of the Syrphidae of Colorado. Colo. Agr. Exp. Sta. Bul., 269:1-73. 8 pls.

KAMAL, MOHAMMED.

- 1926a. A study of some hymenopterous parasites of aphidophagous Syrphidae. Jour. Econ. Ent., 19:5:721-730.

- 1926b. Four new species of parasites from aphidophagous Syrphidae. *Can. Ent.*, 58:11:283-286.
- KEIFER, H. H.
1930. Synopsis of dipterous larvae found in California fruits. *Mo. Bul. Cal. St. Dept. Ag.*, 19:8:574-581.
- KEILIN, D.
1915-6. Recherches sur les larves de diptères Cyclorhaphes. *Bul. Sci. France et Belgique*, 49:25-198. 16 pls.
- KRÜGER, FRIEDERICH.
1926. Biologie und Morphologie einiger syrphiden Larven. *Ztschr. f. Morph. Oekol. Tiere*, 6:83-147. 27 figs.
- KÜNKEL D' HERCULAIS, J.
1875. Recherches sur l'organisation et le développement des Volucelles, insectes diptères de la famille des Syrphides. Libraire de l'Académie de Médecine, Paris. pp. iv + 208. Atlas.
- LATTA, RANDALL, and COLE, F. R.
1933. A comparative study of the species of *Eumerus*, known as lesser bulb flies. *Mo. Bul. Cal. St. Dept. Ag.*, 22:142-152. 2 pls.
- LUNDBECK, WILLIAM.
1916. *Diptera Danica*, Part V, pp. 18-591. 198 figs. G. E. C. Gad, Copenhagen.
- MALLOCH, J. R.
1915. Some additional records of Chironomidae for Illinois and notes on other Illinois Diptera. *Ill. State Lab. Nat. Hist. Bul.*, 11:305-363. 5 pls.
1921. Forest insects of Illinois. I. The sub-family Ochthiphilinae (Diptera, Agromyzidae). *Ill. State Lab. Nat. Hist. Bul.*, 13:345-357. 2 pls.
- METCALF, C. L.
1911a. A preliminary report on the life histories of two species of Syrphidae. *Ohio Nat.*, 11:7:337-344. 2 pls.
1911b. Life histories of Syrphidae II. *Ohio Nat.*, 12:1:397-404. 1 pl.
1912a. Life histories of Syrphidae III. *Ohio Nat.*, 12:5:477-488. 1 pl.
1912b. Life histories of Syrphidae IV. *Ohio Nat.*, 12:8:533-541. 1 pl.
1913a. Life histories of Syrphidae V. *Ohio Nat.*, 13:5:81-93. 2 pls.
1913b. The Syrphidae of Ohio. *Ohio Biol. Surv. Bul.*, 1:9-123. 11 pls. 2 figs.
1916. The Syrphidae of Maine. *Me. Agr. Exp. Sta. Bul.*, 253:193-264. 9 pls.
1917. The Syrphidae of Maine—second report. *Me. Agr. Exp. Sta. Bul.*, 263:153-176. 5 pls.
1933. An obscure *Temnostoma* differentiated by its larval characters. *Ann. Ent. Soc. Amer.*, 26:1-8. 2 pls.
- OSBURN, R. C.
1908. Further list of Syrphidae of British Columbia. *Can. Ent.*, 40:1:1-14.
- PARKER, J. B.
1915. Pupa of *Brachypalpus frontosus* Lw. *Proc. Ent. Soc. Wash.*, 17:4:147.
- RICHARDSON, C. H.
1915. A contribution to the life history of the corn-feeding syrphus fly (*Mesogramma polita* Say). *Jour. Ec. Ent.*, 8:338-342. 1 pl.
- RILEY, C. V., and HOWARD, L. O.
1888. The corn-feeding syrphus fly. *Ins. Life*, 1:5-8. 1 fig.
- SACK, P.
1931. Syrphidae (Diptera) der Deutschen Limnologischen Sunda-Expedition. *Arch. Hydrobiol., Suppl.-Bd.*, 8:585-592. 8 figs.

SANDERSON, E. D.

1900. Report of the Entomologist. Del. Agr. Exp. Sta. Ann. Rpt. (1900), pp. 202-205. 1 pl.

SMITH, J. B.

1890. Plant lice and how to deal with them. N. J. Ag. Col. Exp. Sta. Bul., 72:11-14.

SMITH, R. H.

1923. The clover aphid; biology, economic relationships and control. Idaho Agr. Exp. Sta. Res. Bul., 3:1-75. 4 figs.

TOWNSEND, C. H. T.

1897. Description of the pupa of *Baccha clavata*. Jour. N. Y. Ent. Soc., 5:172.

VERRALL, G. H.

1901. British flies, Syrphidae, etc. Vol. VIII, pp. 127-691. figs. 118-458. Gurney and Jackson, London.

VIMMER, ANT.

1933. Keys to the larvae and pupae of Czechoslovakian syrphids. Casopsis Ceskoslovenske Spolecnosti Entomologicke, 30:181-187. 15 figs.

WALSH, B. D., and RILEY, C. V.

1869. The root-louse syrphus fly (*Pipiza radicum* n. sp.). Amer. Ent., 1:83. 1 fig.

WATSON, J. R.

1926. Citrus fruits and their control. Fla. Ag. Exp. Sta. Bul., 183:367-368. 2 figs.

WHEELER, W. M.

1901. *Microdon* larvae in *Pseudomyrma* nests. Psyche, 9:222-224. 1 fig.
1908. Studies on Myrmecophiles III. *Microdon*. Jour. N. Y. Ent. Soc., 16:4: 202-213. 1 fig.
1910. Ants, their structure, development and behavior. Columbia Univ. Biol. Ser., 9. Columbia University Press, New York. pp. xxv + 1-663. 286 figs.

WILCOX, JOSEPH.

1926. The lesser bulb fly, *Eumerus strigatus* Fallen, in Oregon. Jour. Ec. Ent., 19:762-772. 1 pl. 3 figs.
1927. Observations on the life history, habits and control of the narcissus bulb fly, *Merodon equestris* Fabr. and the lesser bulb fly, *Eumerus strigatus* Fallen, in Oregon. 19th Bienn. Rept. Ore. St. Bd. Hort., pp. 149-158. 1 pl. 2 figs.

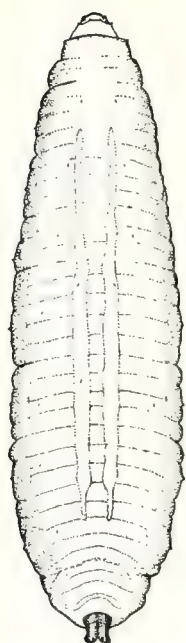
WILCOX, JOSEPH, and MOTE, D. C.

1927. Observations on the life history, habits and control of the narcissus bulb fly, *Merodon equestris* Fabr. in Oregon. Jour. Ec. Ent., 20:708-714. 1 pl.

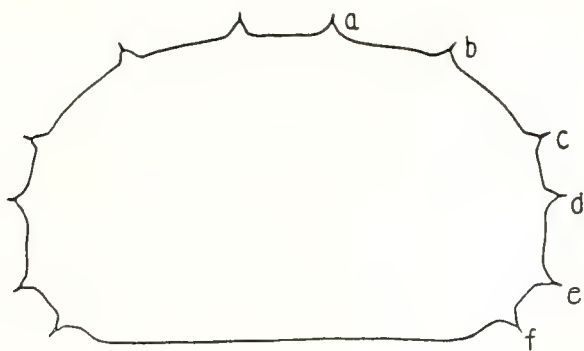
PLATES

PLATE I

- FIG. 1. *Sphaerophoria cylindrica*, dorsal aspect of larva.
FIG. 2. Cross section of an aphidophagous larva (after Metcalf):
a. median, b. dorsal, c. dorso-lateral, d. lateral, e. posterior ventro-lateral, and f. anterior ventro-lateral segmental spines.
FIG. 3. *Sphaerophoria cylindrica*, posterior respiratory process.
FIG. 4. *Sphaerophoria cylindrica*, posterior spiracular plates.
FIG. 5. *Sphaerophoria cylindrica*, rectal gills *in situ*.
FIG. 6. *Sphaerophoria robusta*, posterior spiracular plates.
FIG. 7. *Allograpta obliqua*, rectal gills *in situ*.
FIG. 8. *Allograpta obliqua*, posterior respiratory process.
FIG. 9. *Allograpta obliqua*, posterior spiracular plates.

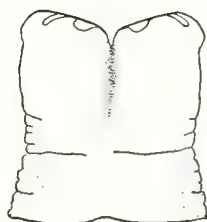


1 *Sphaerophoria cylindrica* 10 mm.

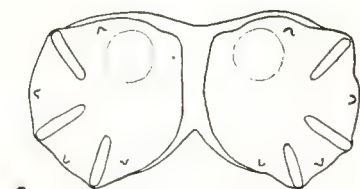


Cross-section of larva

2



3 *S. cylindrica*

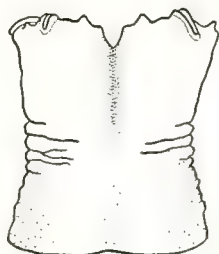


4

S. cylindrica

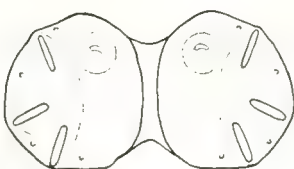


5 *S. cylindrica*



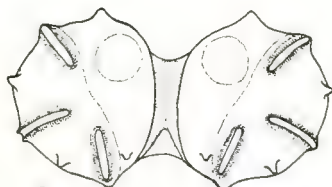
6

S. robusta



7 *A. obliqua*

8 *A. obliqua*



9

A. obliqua

PLATE II

- FIG. 10. *Mesogramma polita*, dorsal aspect of mature larva.
FIG. 11. *Mesogramma polita*, second instar larva and corn anther.
FIG. 12. *Mesogramma polita*, posterior spiracular plates.
FIG. 13. *Mesogramma polita*, puparium among florets of corn tassel.
FIG. 14. *Mesogramma marginata*, posterior spiracular plates (after Fluke).
FIG. 15. *Mesogramma marginata*, lateral aspect of puparium (after Fluke).
FIG. 16. *Mesogramma polita*, lateral aspect of puparium.
FIG. 17. *Mesogramma geminata*, posterior spiracular plates.
FIG. 18. *Mesogramma polita*, dorsal aspect of puparium.

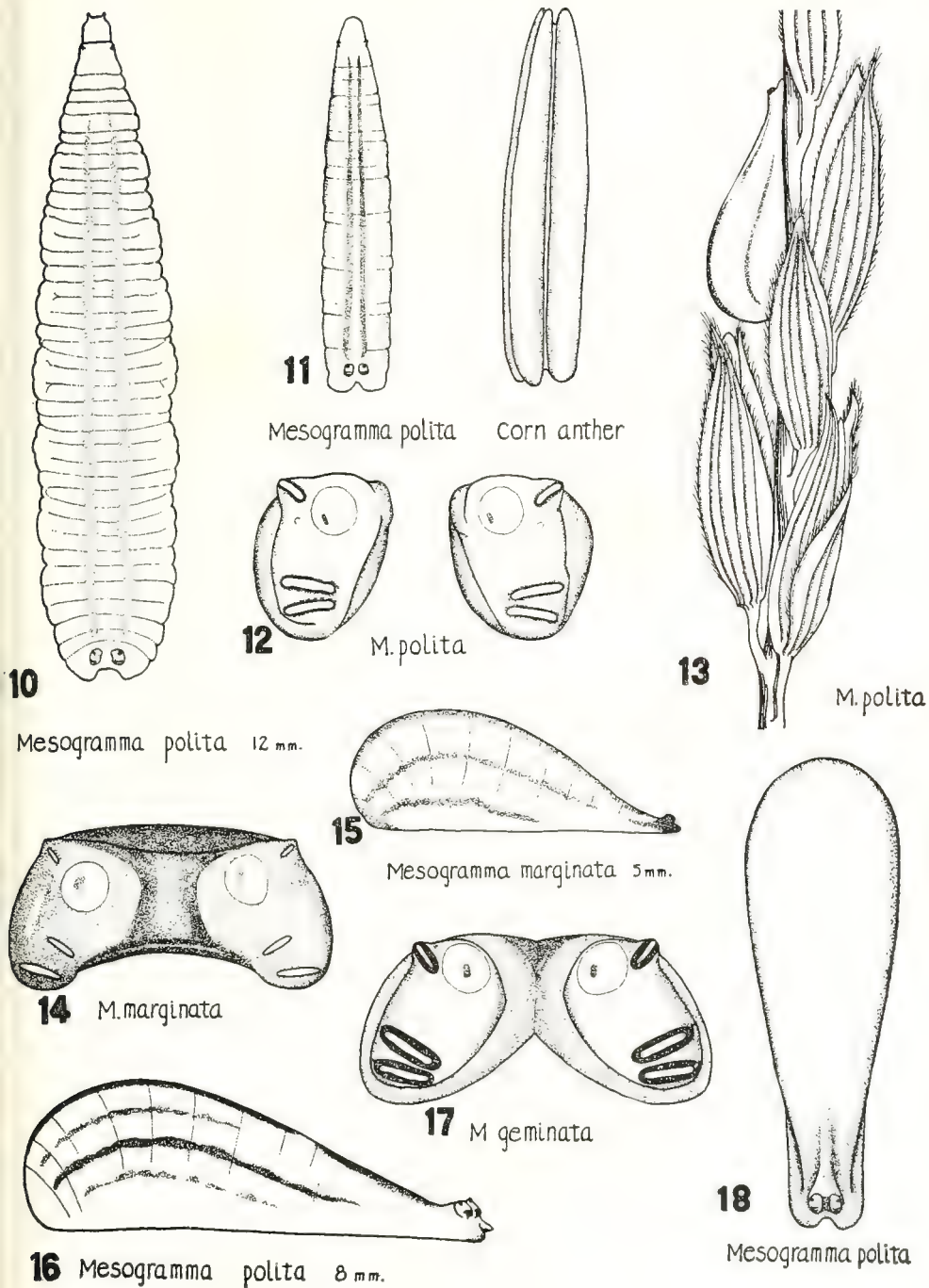
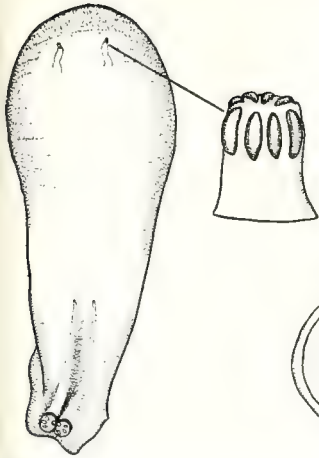


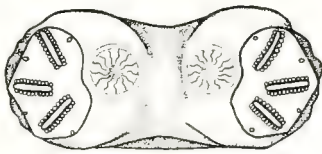
PLATE II

PLATE III

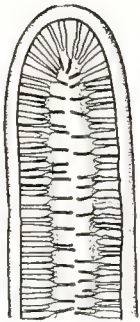
- FIG. 19. *Melanostoma mellinum*, dorsal aspect of puparium and pupal respiratory horn (after Metcalf).
- FIG. 20. *Platychirus perpallidus*, posterior spiracular plates (after Metcalf).
- FIG. 21. *Melanostoma obscurum*, posterior spiracular plates.
- FIG. 22. *Lasiophthicus pyrastris*, chitinous bars of posterior spiracle.
- FIG. 23. *Eupeodes volucris*, posterior spiracular plates.
- FIG. 24. *Lasiophthicus pyrastris*, posterior spiracular plates.
- FIG. 25. *Eupeodes volucris*, dorsal aspect of larva.
- FIG. 26. *Eupeodes volucris*, segmental spine.
- FIG. 27. *Eupeodes volucris*, posterior respiratory process from above.
- FIG. 28. *Lasiophthicus pyrastris*, lateral aspect of puparium.



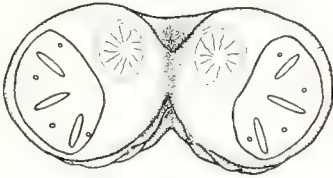
19 *Melanostoma mellinum* 6 mm



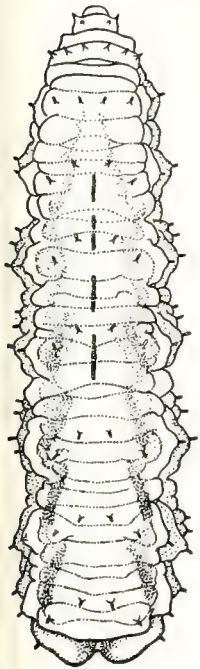
20 *Platycheirus perpallidus*



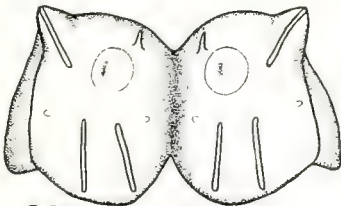
22
L. pyrastris



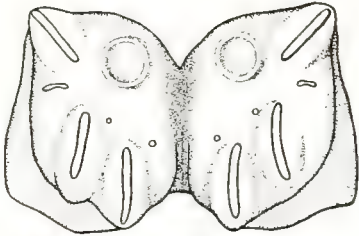
21
M. Obscurum



25
Eupodes volucris
10 mm.



23
E. volucris



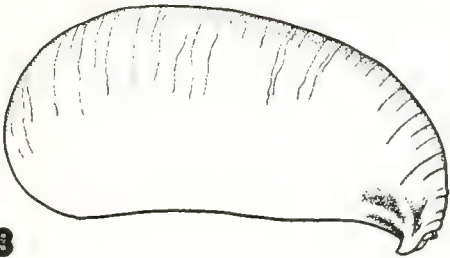
24
L. pyrastris



27
E. volucris



26
E. volucris



28
Lasiothricus pyrastris 8 mm.

PLATE IV

- FIG. 29. *Syrphus rectus*, dorsal aspect of larva: d.b.v. dorsal blood vessel, d.l. dorsal line, ar. arrow, ch. chevron.
- FIG. 30. *Syrphus rectus*, posterior spiracular plates.
- FIG. 31. *Syrphus rectus*, posterior respiratory process from above.
- FIG. 32. *Syrphus rectus*, rectal gills *in situ*.
- FIG. 33. *Syrphus torvus*, posterior spiracular plates.
- FIG. 34. *Syrphus rectus*, segmental spine.
- FIG. 35. *Syrphus rectus*, chitinous bars of posterior spiracle.
- FIG. 36. *Syrphus ribesii* var. *vittafrons*, posterior spiracular plates.
- FIG. 37. *Syrphus ribesii* var. *vittafrons*, lateral aspect of puparium.
- FIG. 38. *Syrphus knabi*, posterior spiracular plates.
- FIG. 39. *Syrphus knabi*, posterior respiratory process from above

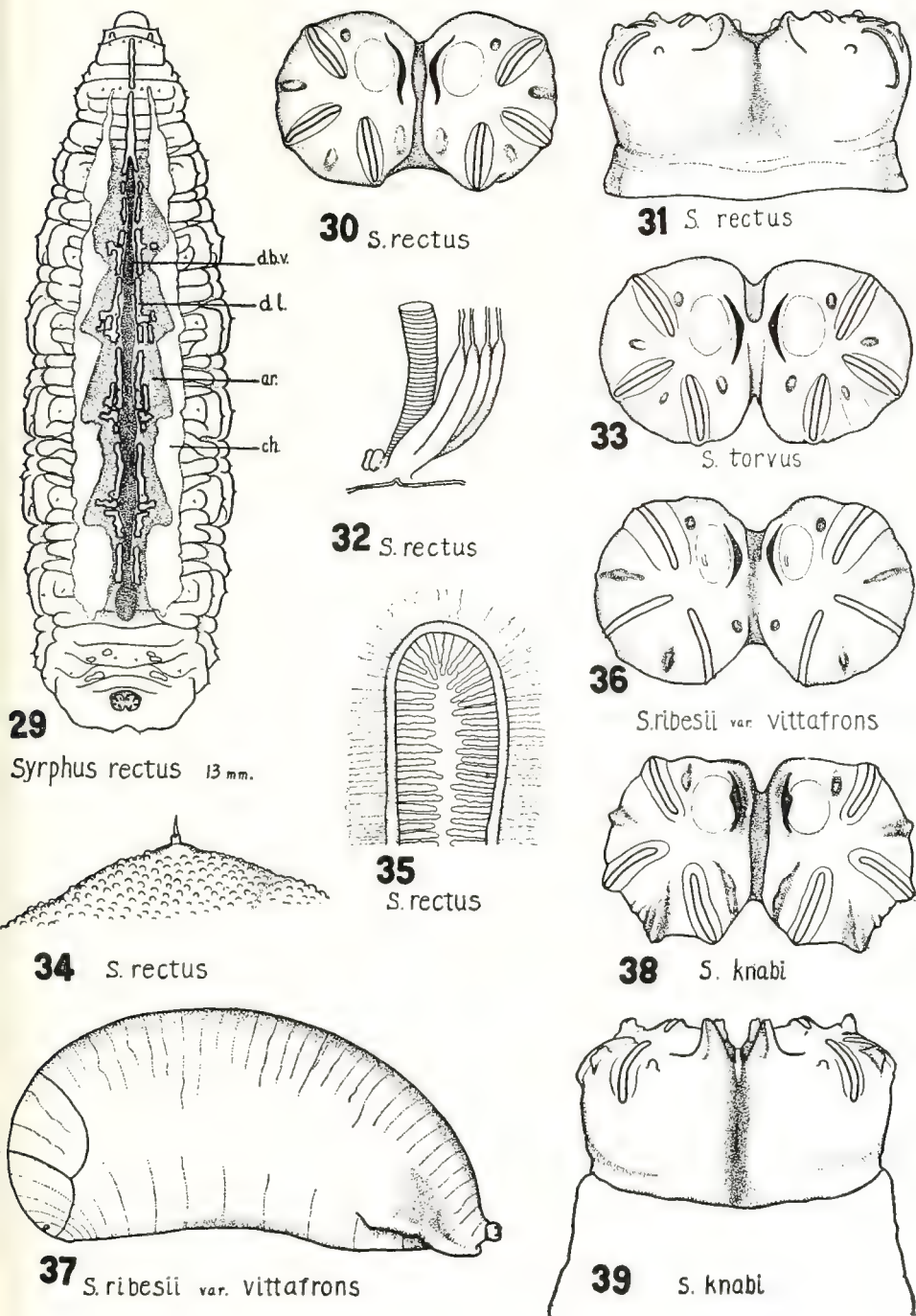
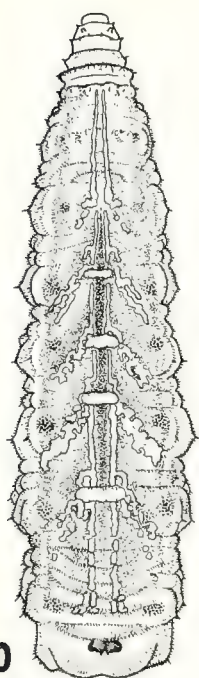


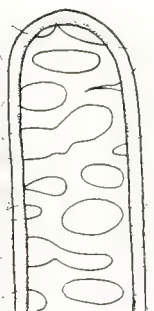
PLATE V

- FIG. 40. *Metasyrphus wiedemanni*, dorsal aspect of larva.
FIG. 41. *Metasyrphus wiedemanni*, seive plate of posterior spiracle.
FIG. 42. *Metasyrphus nitens* (?), posterior spiracular plates (after Metcalf).
FIG. 43. *Metasyrphus canadensis*, posterior spiracular plates.
FIG. 44. *Metasyrphus meadii*, posterior spiracular plates.
FIG. 45. *Metasyrphus wiedemanni*, posterior spiracular plates.
FIG. 46. *Metasyrphus vinelandi*, segmental spine.
FIG. 47. *Metasyrphus perplexus*, posterior spiracular plates.
FIG. 48. *Metasyrphus wiedemanni*, rectal gills extruded.
FIG. 49. *Metasyrphus vinelandi*, posterior spiracular plates.

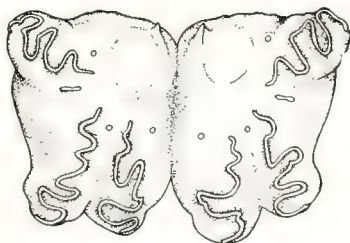


40

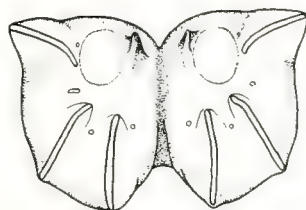
Metasyrphus wiedemanni 12 mm.



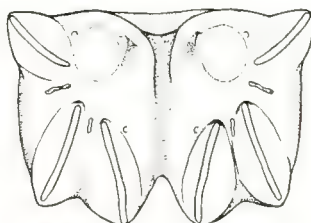
41 *M. wiedemanni*



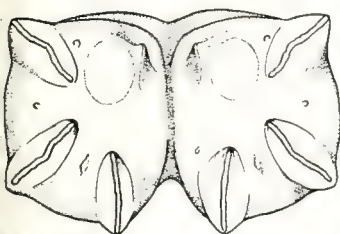
42 *M. nitens* (?)



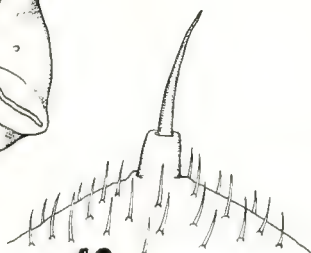
43 *M. canadensis*



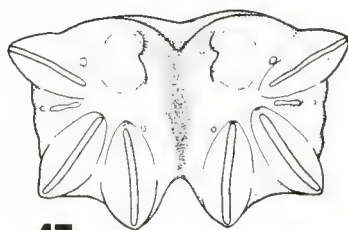
44 *M. meadii*



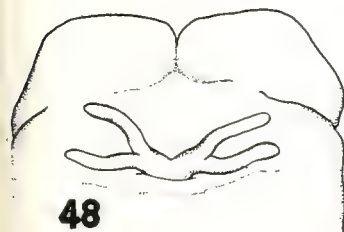
45 *M. wiedemanni*



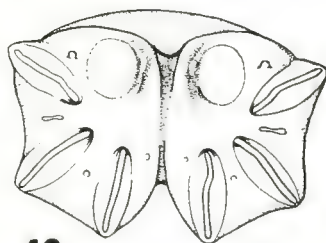
46 *M. vinelandi*



47 *M. perplexus*



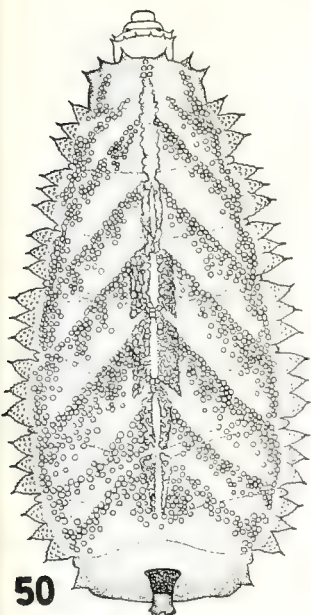
48 *M. wiedemanni*



49 *M. vinelandi*

PLATE VI

- FIG. 50. "*Metasyrphus*" *emarginatus*, dorsal aspect of larva.
FIG. 51. "*Metasyrphus*" *emarginatus*, lateral aspect of puparium.
FIG. 52. "*Metasyrphus*" *emarginatus*, rectal gills *in situ*.
FIG. 53. "*Metasyrphus*" *divisus*, posterior respiratory process.
FIG. 54. "*Metasyrphus*" *divisus*, posterior spiracular plates.
FIG. 55. "*Metasyrphus*" *invigorus*, posterior spiracular plates.
FIG. 56. "*Metasyrphus*" *emarginatus*, segmental spine.
FIG. 57. "*Metasyrphus*" *emarginatus*, posterior respiratory process.
FIG. 58. "*Metasyrphus*" *emarginatus*, posterior spiracular plates.
FIG. 59. "*Metasyrphus*" *invigorus*, posterior respiratory process.



50



51 "Metasyrphus" emarginatus 4.6 mm.



53

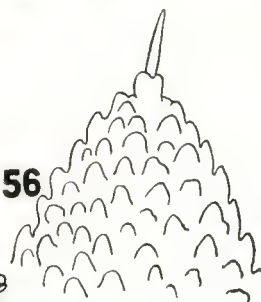
"M." divisus



54 "M." divisus

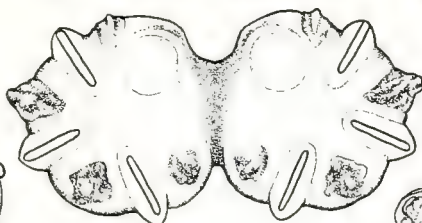


52



56

"M." emarginatus

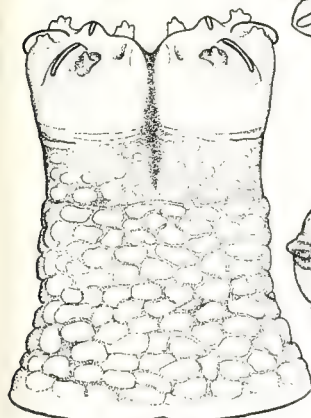


55 "M." invigoratus



58

"M." emarginatus



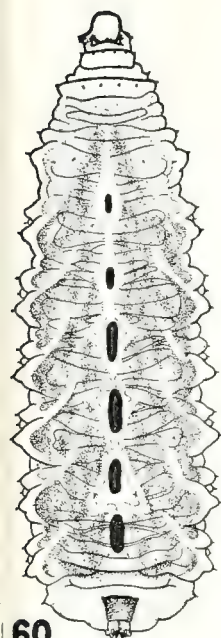
57 "M." emarginatus



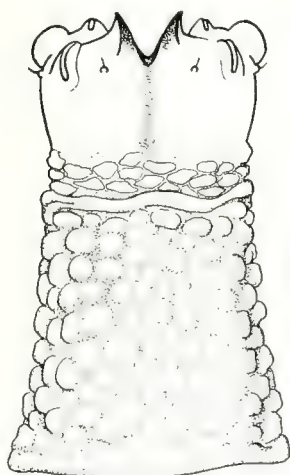
59 "M." invigoratus

PLATE VII

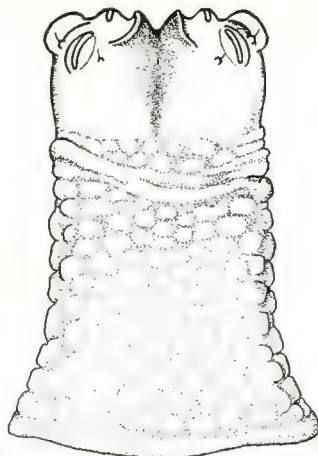
- FIG. 60. *Epistrophe cinctus*, dorsal aspect of larva.
FIG. 61. *Epistrophe cinctus*, posterior respiratory process.
FIG. 62. *Epistrophe triangulifer*, posterior respiratory process.
FIG. 63. *Epistrophe cinctus*, segmental spine.
FIG. 64. *Epistrophe cinctus*, posterior spiracular plates.
FIG. 65. *Epistrophe triangulifer*, posterior spiracular plates.
FIG. 66. *Epistrophe cinctus*, dorsal aspect of puparium.
FIG. 67. *Pipiza femoralis*, lateral aspect of puparium.
FIG. 68. *Epistrophe cinctus*, lateral aspect of puparium.



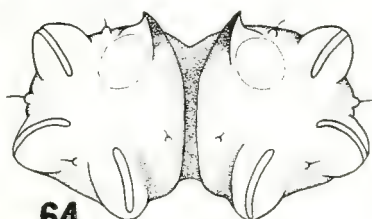
60
Epistrophe cinctus 11 mm.



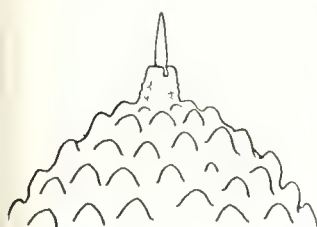
61 *E. cinctus*



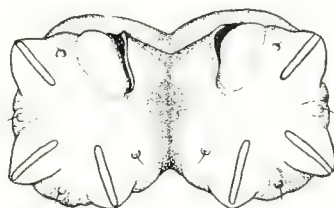
62
E. triangulifer



64
E. cinctus



63 *E. cinctus*



65
E. triangulifer



66
Epistrophe cinctus 8 mm.



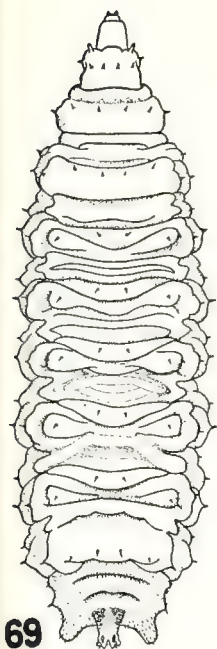
67
Pipiza femoralis 8 mm.



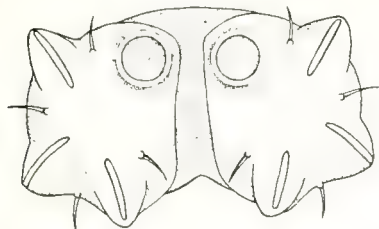
68
Epistrophe cinctus 8 mm.

PLATE VIII

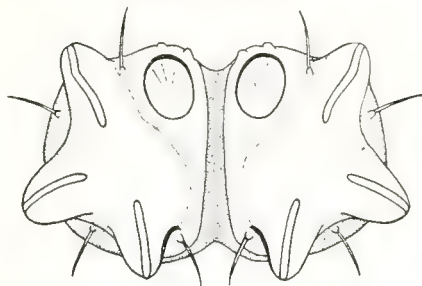
- FIG. 69. *Pipiza femoralis*, dorsal aspect of larva.
FIG. 70. *Pipiza pisticoides*, posterior spiracular plates.
FIG. 71. *Pipiza femoralis*, posterior spiracular plates.
FIG. 72. *Pipiza pisticoides*, dorsal aspect of larva.
FIG. 73. *Pipiza pisticoides*, segmental spine.
FIG. 74. *Paragus bicolor*, posterior respiratory process.
FIG. 75. *Paragus tibialis*, posterior respiratory process.
FIG. 76. *Pipiza femoralis*, segmental spine.
FIG. 77. *Paragus tibialis*, lateral aspect of puparium.



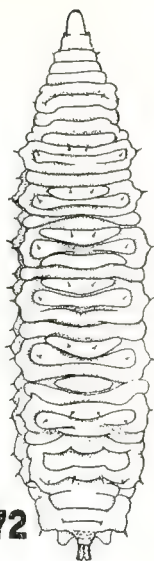
69
Pipiza femoralis 11 mm.



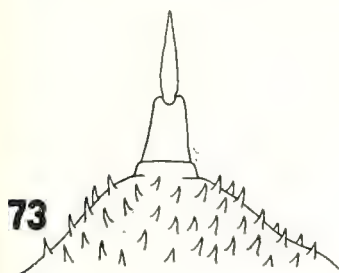
70 *P. pisticoidea*



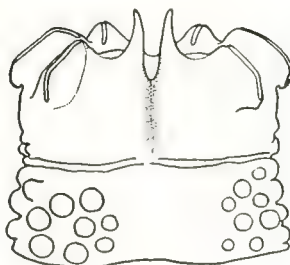
71 *P. femoralis*



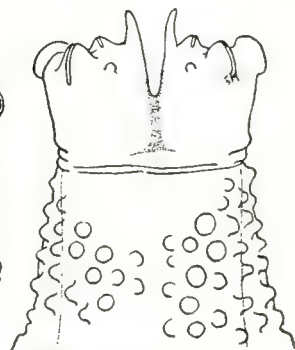
72
Pipiza pisticoidea
9 mm.



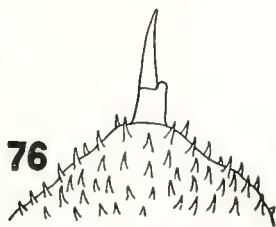
73
P. pisticoidea



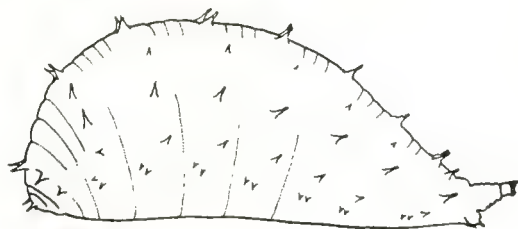
74 *P. bicolor*



75 *P. tibialis*



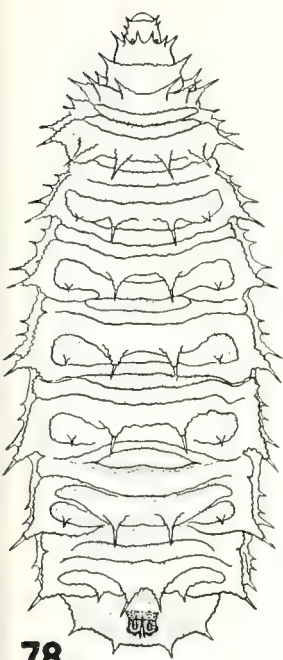
76
P. femoralis



77 *Paragus tibialis* 2.5 mm.

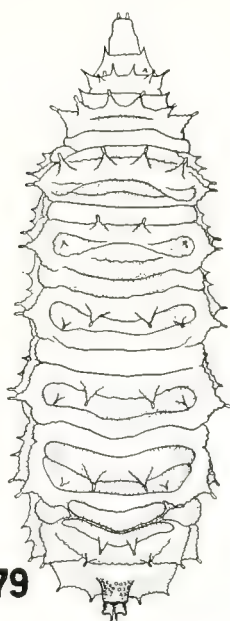
PLATE IX

- FIG. 78. *Paragus bicolor*, dorsal aspect of larva.
FIG. 79. *Paragus tibialis*, dorsal aspect of larva.
FIG. 80. *Didea fasciata*, segmental spine.
FIG. 81. *Paragus bicolor*, segmental spine.
FIG. 82. *Paragus tibialis*, segmental spine.
FIG. 83. *Didea fasciata*, posterior spiracular plates.
FIG. 84. *Didea fasciata*, dorsal aspect of larva.



78

Paragus bicolor 7 mm.

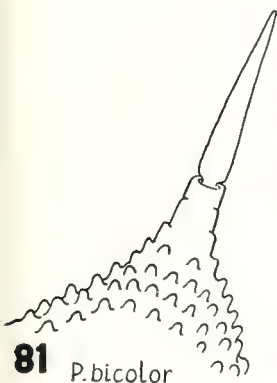


79

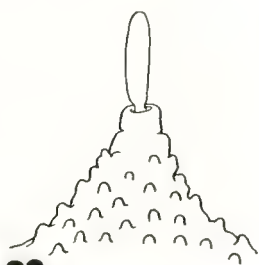
Paragus tibialis 6 mm.



80 *D. fasciata*

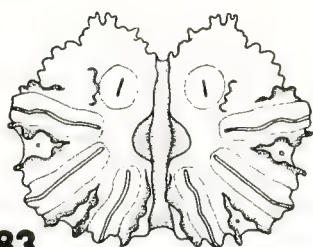


81 *P. bicolor*



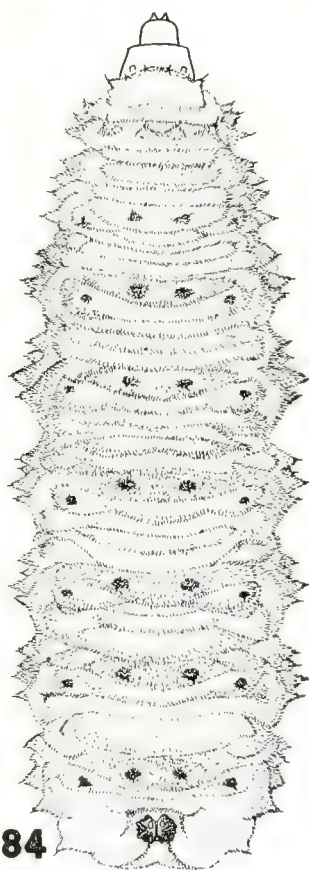
82

P. tibialis



83

D. fasciata



84

Didea fasciata 15 mm.

PLATE X

- FIG. 85. *Baccha clavata*, lateral aspect of larva.
FIG. 86. *Baccha clavata*, lateral aspect of puparium.
FIG. 87. *Baccha clavata*, end view of posterior spiracular plates.
FIG. 88. *Baccha clavata*, posterior spiracular plates from below.
FIG. 89. *Baccha clavata*, segmental spine.
FIG. 90. *Baccha clavata*, posterior respiratory process from the side.
FIG. 91. *Baccha clavata*, dorsal view of puparium.
FIG. 92. *Baccha lugens*, lateral view of puparium.
FIG. 93. *Baccha lugens*, posterior spiracular plates.
FIG. 94. *Chrysotoxum pubescens*, lateral aspect of puparium
(after Greene).
FIG. 95. *Chrysotoxum pubescens*, posterior spiracular plates
(after Greene).



85

Baccha clavata

10 mm.



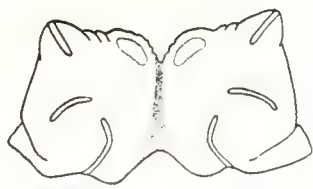
86

Baccha clavata 6mm.



87

B. clavata



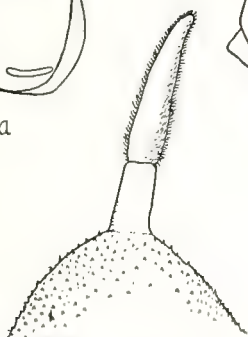
88

B. clavata



91

Baccha clavata 6 mm



89

B. clavata



90

B. clavata



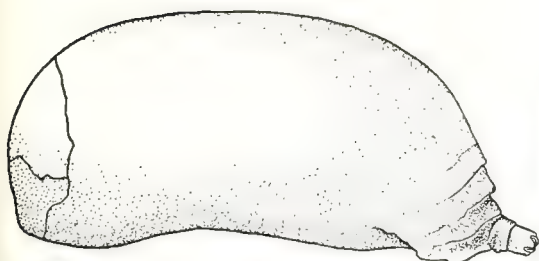
92

Baccha lugens 5 mm.



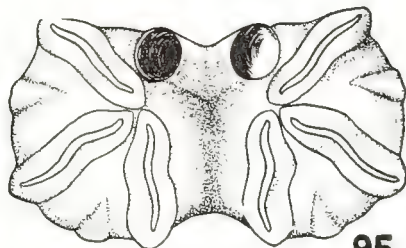
93

B. lugens



94

Chrysotoxum pubescens 8mm.

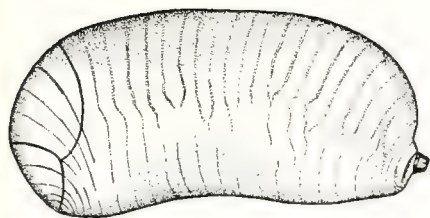


95

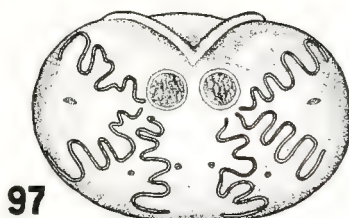
C. pubescens

PLATE XI

- FIG. 96. *Xanthogramma flavipes*, lateral aspect of puparium.
FIG. 97. *Xanthogramma flavipes*, posterior spiracular plates.
FIG. 98. *Xylota pigra*, lateral aspect of puparium.
FIG. 99. *Xylota fraudulosa*, lateral hooks.
FIG. 100. *Xylota nemorum*, lateral hooks.
FIG. 101. *Xylota fraudulosa*, lateral aspect of puparium.
FIG. 102. *Xylota nemorum*, dorsal aspect of puparium.
FIG. 103. *Xylota* sp., ventral aspect of larva.



96 *Xanthogramma flavipes* 8 mm.



97 *X. flavipes*



98

Xylota plaga 11 mm.



99

X. fraudulosa

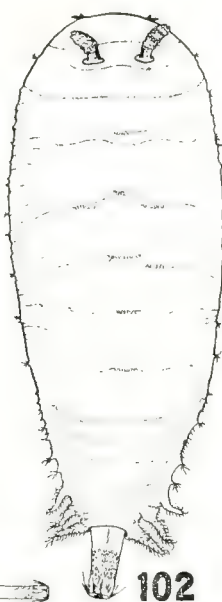


100

X. nemorum

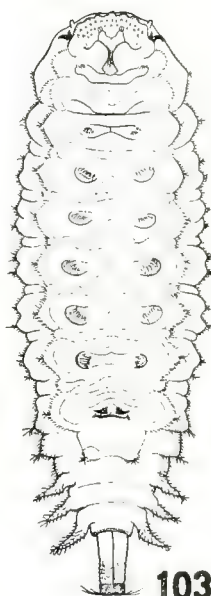


101 *Xylota fraudulosa* 7 mm



102

Xylota nemorum 8 mm.

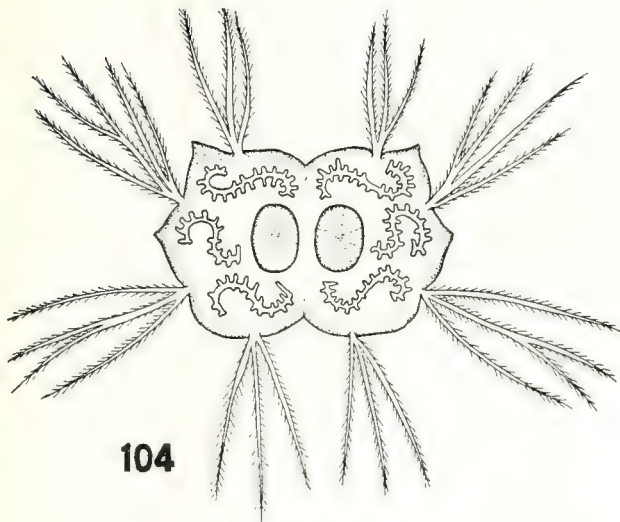


103

Xylota sp. 10 mm.

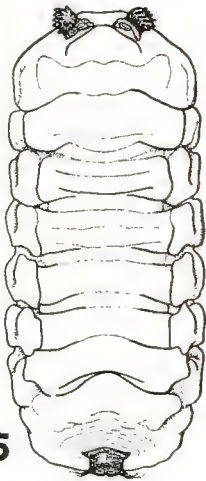
PLATE XII

- FIG. 104. *Xylota nemorum*, posterior spiracular plates.
FIG. 105. *Temnostoma bombylans*, dorsal aspect of larva.
FIG. 106. *Temnostoma balyras*, posterior spiracular plates.
FIG. 107. *Temnostoma bombylans*, posterior spiracular plates.
FIG. 108. *Temnostoma bombylans*, lateral aspect of puparium.



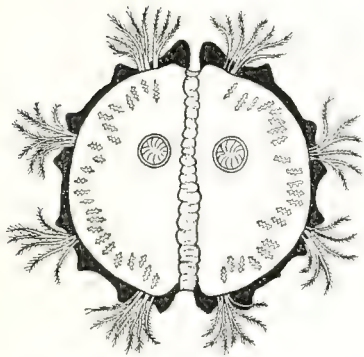
104

X. nemorum



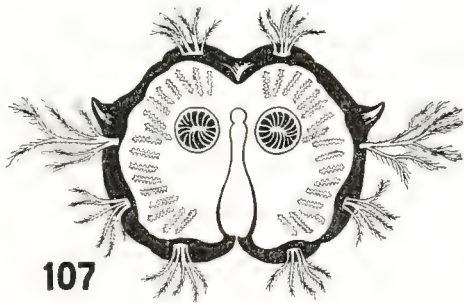
105

Temnostoma bombylans 10 mm.



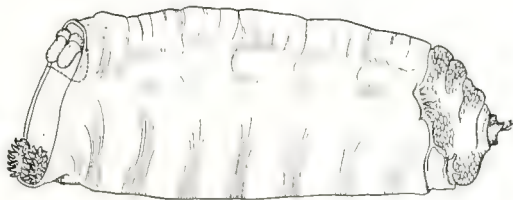
106

T. balyras



107

T. bombylans

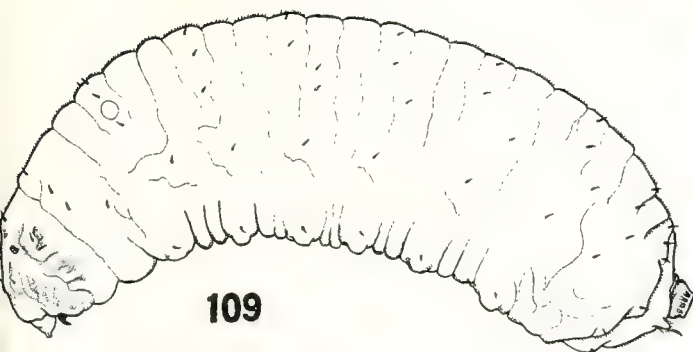


108

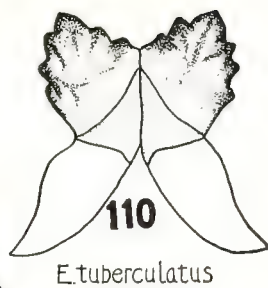
Temnostoma bombylans 10 mm.

PLATE XIII

- FIG. 109. *Merodon equestris*, lateral aspect of larva.
FIG. 110. *Eumerus tuberculatus*, mandibular sclerites (after Hodson).
FIG. 111. *Merodon equestris*, lateral aspect of puparium.
FIG. 112. *Merodon equestris*, posterior spiracular plate.
FIG. 113. *Eumerus strigatus*, lateral aspect of larva.
FIG. 114. *Eumerus strigatus*, mandibular sclerites (after Hodson).
FIG. 115. *Eumerus tuberculatus*, antennal papillae (after Hodson).
FIG. 116. *Eumerus strigatus*, antennal papillae (after Hodson).



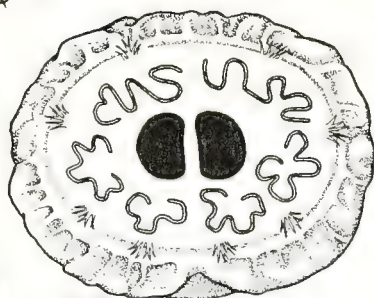
109 *Merodon equestris* 15 mm



110 *E. tuberculatus*



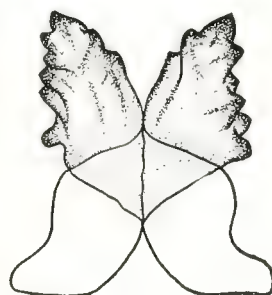
111 *Merodon equestris* 13 mm.



112 *M. equestris*



113 *Eumerus strigatus* 9 mm.



114 *E. strigatus*



115 *E. tuberculatus*



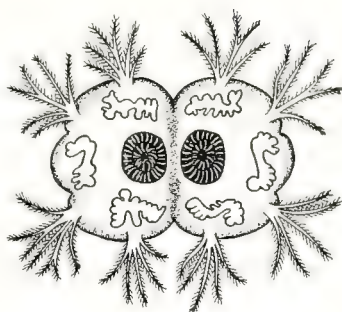
116 *E. strigatus*

PLATE XIV

- FIG. 117. *Syritta pipiens*, lateral aspect of larva (after Hodson).
FIG. 118. *Syritta pipiens*, posterior spiracular plates (after Metcalf).
FIG. 119. *Eumerus strigatus*, segmental spine.
FIG. 120. *Eumerus strigatus*, pupal respiratory horn.
FIG. 121. *Syritta pipiens*, pupal respiratory horn (after Metcalf).
FIG. 122. *Eumerus strigatus*, posterior spiracular plates.
FIG. 123. *Eumerus strigatus*, lateral aspect of puparium.
FIG. 124. *Syritta pipiens*, rectal gills extruded (after Krüger).
FIG. 125. *Eumerus strigatus*, rectal gills extruded and *in situ*.
FIG. 126. *Syritta pipiens*, lateral aspect of puparium (after Hodson).
FIG. 127. *Eumerus strigatus*, caudal region of larva, dorsal aspect.
FIG. 128. *Syritta pipiens*, caudal region of larva, dorsal aspect
(after Metcalf).



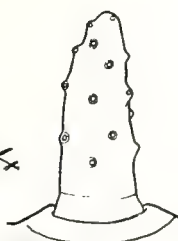
117 *Syrretta pipiens* 10 mm.



118 *S. pipiens*



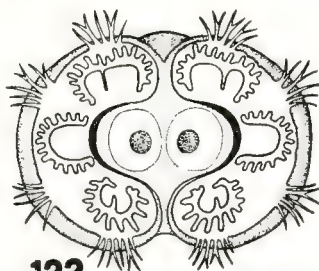
119 *E. strigatus*



120 *E. strigatus*



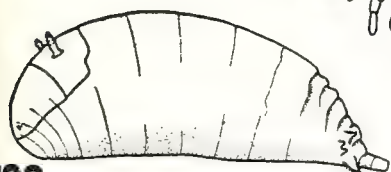
121 *S. pipiens*



122 *E. strigatus*



124 *S. pipiens*



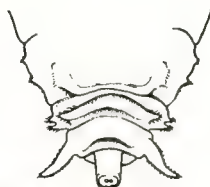
123 *Eumerus strigatus* 5.5 mm



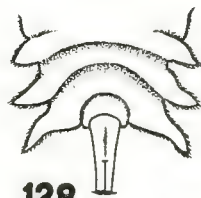
125 *E. strigatus*



126 *Syrretta pipiens* 7 mm.



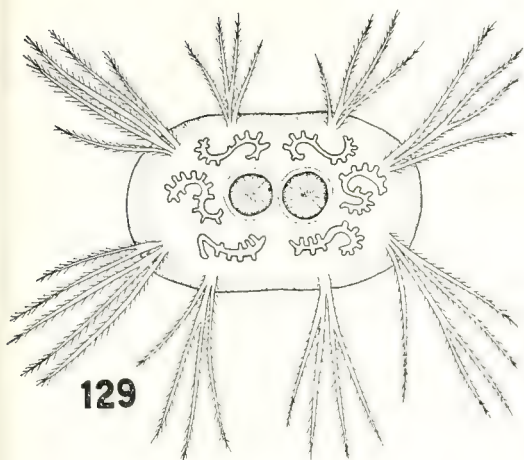
127 *E. strigatus*



128 *S. pipiens*

PLATE XV

- FIG. 129. *Brachypalpus frontosus*, posterior spiracular plate.
FIG. 130. *Brachypalpus frontosus*, lateral hook.
FIG. 131. *Brachypalpus rileyi*, lateral hooks (after Greene).
FIG. 132. *Brachypalpus frontosus*, pupal respiratory horn.
FIG. 133. *Brachypalpus rileyi*, pupal respiratory horn (after Greene).
FIG. 134. *Brachypalpus frontosus*, ventral aspect of larva.
FIG. 135. *Brachypalpus frontosus*, segmental spine.
FIG. 136. *Brachypalpus frontosus*, dorsal view of anterior region.
FIG. 137. *Brachypalpus frontosus*, lateral aspect of puparium.



129

B. frontosus



130

B. frontosus



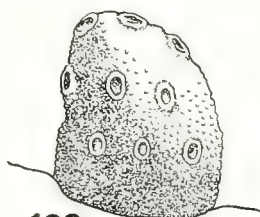
131

B. rileyi



132

B. frontosus



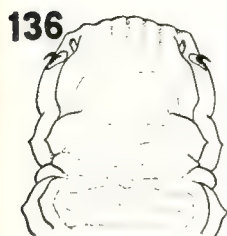
133

B. rileyi



135

B. frontosus



136

B. frontosus—dorsal view



134

Brachypalpus frontosus 19 mm.

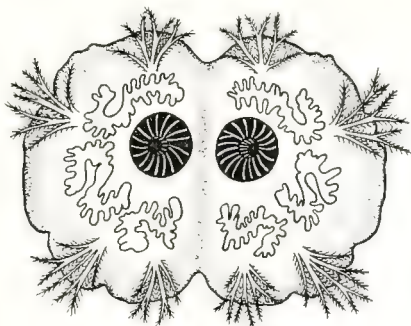
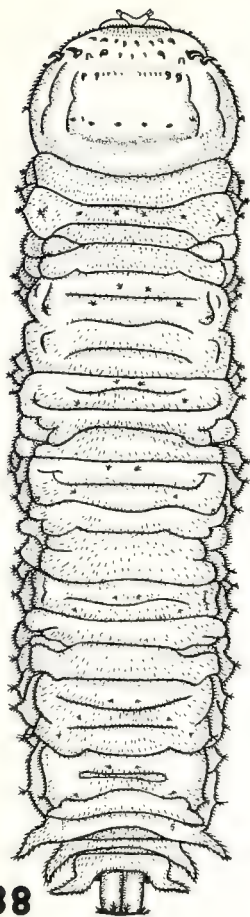


137

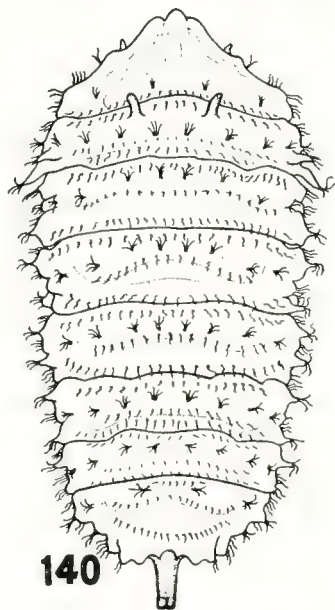
Brachypalpus frontosus 14 mm.

PLATE XVI

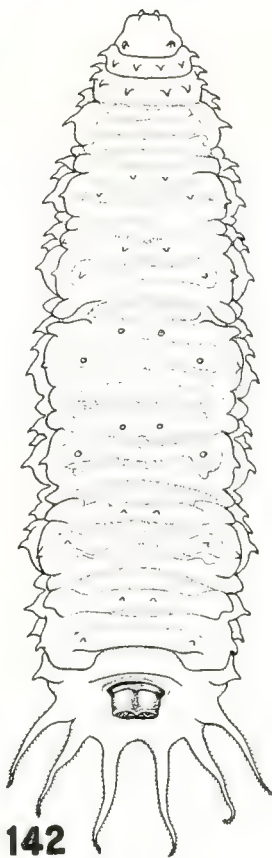
- FIG. 138. *Tropidia quadrata*, dorsal aspect of larva (after Metcalf).
FIG. 139. *Tropidia quadrata*, posterior spiracular plates (after Metcalf).
FIG. 140. *Brachopa vacua*, dorsal aspect of puparium (after Greene).
FIG. 141. *Tropidia quadrata*, lateral aspect of puparium (after Metcalf).
FIG. 142. *Volucella* sp., dorsal aspect of larva.



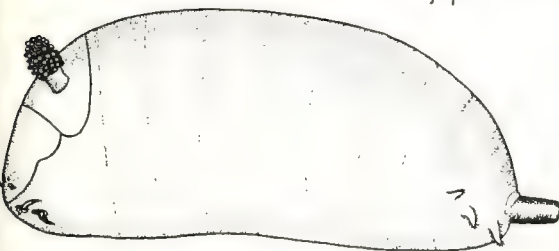
139 *T. quadrata*



140
Brachyopa vacua 8 mm.



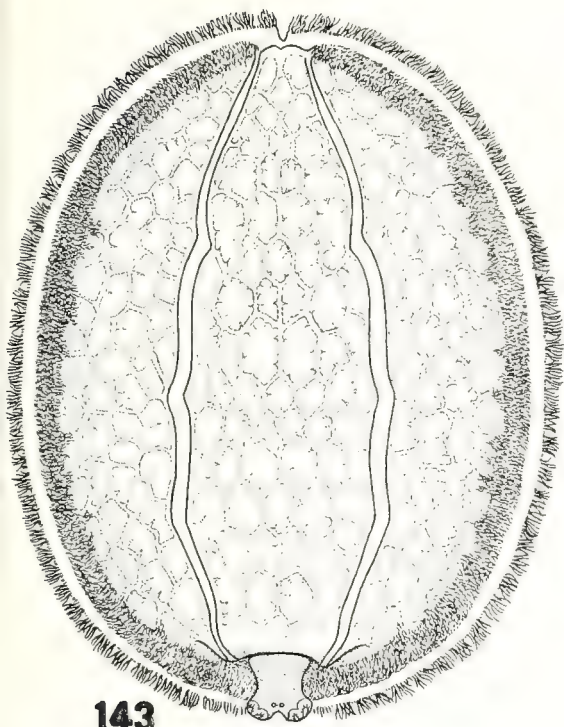
142
Volucella sp. 19 mm.



141 *Tropidia quadrata* 9 mm.

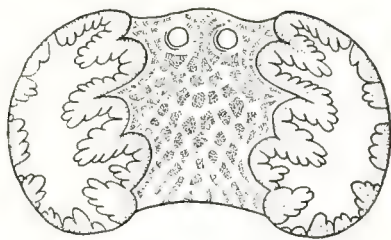
PLATE XVII

- FIG. 143. *Microdon* sp., dorsal aspect of larva.
FIG. 144. *Microdon* sp., posterior spiracular plates.
FIG. 145. *Volucella* sp., posterior spiracular plates.
FIG. 146. *Cerioides signifera*, lateral aspect of puparium.

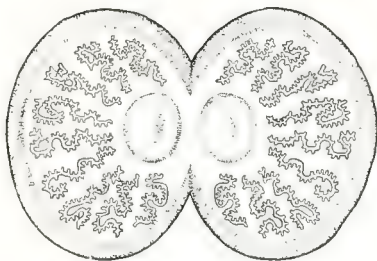


143

Microdon sp. 10 mm.



144 Microdon sp.



145 Volucella sp.



146

Gerioides signifera 14 mm.

INDEX

- Agromyzidae, 20
Allograpta Osten Sacken, 17, 22, 25, 27
 obliqua Say, 27
Aphidoletes meridionalis Felt, 20
 arrow, 43

Baccha Fabricius, 22, 23, 25, 73
 clavata Fabricius, 73
 lugens Loew, 74
balyras (Walker), *Temnostoma*, 81, 83
bicolor Fabricius, *Paragus*, 70
bicolor Loew, *Xylota*, 78, 80
bombylans Fabricius, *Temnostoma*, 81
Brachyopa Meigen, 23, 26, 95
 vacua Osten Sacken, 95
Brachypalpus Macquart, 91
 frontosus Loew, 23, 26, 91, 92
 rileyi Williston, 24, 26, 91, 93

canadensis (Curran), *Metasyrphus*, 50, 55
 carina, 20
 Cecidomyiidae, 20
Ceria signifera Loew, 98
Ceria willistoni Kahl, 98
Cerioides Rondani, 98
 signifera (Loew), 23, 26, 98
 Chalcidae, 18, 99
 chevrons, 43
 chitinous bars, 39, 42, 49
Chrysotoxum Meigen, 75
 pubescens Loew, 24, 26, 75
cinctus (Fallén), *Epistrophe*, 63
 circular plate, 12, 14, 20
clavata Fabricius, *Baccha*, 73
coarctatus Loew, *Microdon*, 97
Cyaniris ladon Cramer, 20
cylindrica Say, *Sphaerophoria*, 28, 29
 Cynipidae, 18, 99

Didea Macquart, 22, 25, 72
 fasciata fuscipes Loew, 72
divisa (Williston), "*Metasyrphus*," 59
divisus (Williston), "*Metasyrphus*," 60
 dorsal line, 43
 dorsal spur, 12, 21

 eggs of Syrphidae, 10
 emarginatus group, 17, 18, 22, 25, 57
 emarginatus (Say), "*Metasyrphus*," 59
Epistrophe Walker, 17, 18, 22, 24, 63
 cinctus (Fallén), 63
 triangulifer Zetterstedt, 63, 65
equestris Fabricius, *Merodon*, 84
erraticus Curran, *Platychirus*, 37
Eumerus Meigen, 23, 27, 85
 narcissi Smith, 86
 strigatus Fallén, 87
 tuberculatus Rondani, 87, 88
Eupeodes Osten Sacken, 22, 25, 26, 40
 volucris Osten Sacken, 41

 false head, 13, 21
fasciata fuscipes Loew, *Didea*, 72
felix (Fluke), "*Metasyrphus*," 62
femoralis Loew, *Pipiza*, 66, 67
flavipes Loew, *Xanthogramma*, 24, 76
 food habits, 15
fraudulosa Loew, *Xylota*, 78
frontosus Loew, *Brachypalpus*, 23, 26, 91, 92

geminata Say, *Mesogramma*, 31, 34
 generic relationships, 17
globosus Fabricius, *Microdon*, 97
 glossary, 20

hyperboreus Staeger, *Platychirus*, 37

 Ichneumonidae, 18, 99
 interspiracular nodules, setae, lamellae, 12, 21
invigor (Curran), "*Metasyrphus*," 62

 keys, 21, 28, 31, 43, 49, 63, 66, 70, 78, 81, 87, 91
 to genera, larvae, 21
 to genera, puparia, 24
knabi Shannon, *Syrphus*, 43, 47

 larva, 11
 aphidophagous type, 11
 saprophytic type, 13
 Microdon type, 14
 larvae resembling Syrphidae, 19
Lasiophthicus Rondani, 22, 25, 38
pyrastris Linnaeus, 39
 lateral thorns, 21
Leucopis americana Malloch, 20

- lugens* Loew, *Baccha*, 74
 Lycaenidae, 20

marginata Say, *Mesogramma*, 31, 33
meadii (Jones), *Metasyrphus*, 50, 54
megalogaster Snow, *Microdon*, 97
Melanostoma Schiner, 17, 18, 22, 24, 26, 34
 mellinum Linnaeus, 35
 obscurum Say, 36
mellinum Linnaeus, *Melanostoma*, 35
menthastri Linnaeus, *Sphaerophoria*, 30
Merodon Meigen, 23, 27, 83
 equestris Fabricius, 84
Mesogramma Loew, 17, 22, 25, 30
 geminata Say, 31, 34
 marginata Say, 31, 33
 polita Say, 31
 "Metasyrphus" *emarginatus* group, 17, 18, 22, 25, 57
 divisa (Williston), 59
 divisus (Williston), 60
 emarginatus (Say), 59
 felix (Fluke), 62
 invigor (Curran), 62
 weborgi (Fluke), 59
Metasyrphus Matsumura and Adachi, 17, 18, 22, 26, 49
 canadensis (Curran), 50, 55
 meadii (Jones), 50, 54
 nitens ? (Zetterstedt), 24, 49, 55
 perplexus (Osburn), 50, 53
 vinelandi (Curran), 50, 52
 wiedemanni (Johnson), 50
Microdon Meigen, 24, 26, 96
 coarctatus Loew, 97
 globosus Fabricius, 97
 megalogaster Snow, 97
 piperi Knab, 97
 tristis Loew, 97
 mouth-hood, 13

narcissi Smith, *Eumerus*, 86
nemorum Fabricius, *Xylota*, 78, 79
nigra Greene, *Volucella*, 26, 96
nitens ? (Zetterstedt), *Metasyrphus*, 24, 49, 55

obliqua Say, *Allograpta*, 27
obscurum Say, *Melanostoma*, 36
 operculum, 15, 21

Paragus Latreille, 23, 25, 70
 bicolor Fabricius, 70
 tibialis Fallén, 71
 parasites, 18, 99
perpallidus Verrall, *Platychirus*, 38
perplexus (Osburn), *Metasyrphus*, 50, 53
pigra Fabricius, *Xylota*, 78, 79
piperi Knab, *Microdon*, 97
pipiens Linnaeus, *Syrpitta*, 90
Pipiza Fallén, 23, 25, 65
 femoralis Loew, 66, 67
 pistacoides Williston, 66, 67
 radicum Walsh and Riley, 66, 69
pistacoides Williston, *Pipiza*, 66, 67
Platychirus St. Fargeau and Serville, 17, 18, 22, 25, 34, 36
 hyperboreus Staeger, 37
 perpallidus Verrall, 38
 quadratus Say, 36
polita Say, *Mesogramma*, 31
 posterior respiratory process, 21
 posterior spiracles, 12, 13, 21
 posterior spiracular plate, 12, 14, 21
pubescens Loew, *Chrysotoxum*, 24, 26, 75
 pupal respiratory horns, 15, 21
 pupariation, 15
 puparium, 14
 aphidophagous type, 14
 saprophytic type, 15
 Microdon type, 15
pyrastri Linnaeus, *Lasiophthicus*, 39

quadrata Say, *Tropidia*, 94
quadratus (Say), *Platychirus*, 36

radicum Walsh and Riley, *Pipiza*, 66, 69
 rectal gills, 11, 12, 14, 21, 27, 32, 43, 49, 59, 68, 71, 73, 74, 88, 91
rectus Osten Sacken, *Syrphus*, 43, 44
ribesii Linnaeus, *Syrphus*, 45
ribesii vittifrons Shannon, *Syrphus*, 43, 45
rileyi Williston, *Brachypalpus*, 24, 26, 91, 92
robusta Curran, *Sphaerophoria*, 28, 29

scripta Fluke, *Sphaerophoria*, 29
 segmental spines, 12, 21
signifera (Loew), *Ceriodides*, 23, 26, 98

- Sphaerophoria* St. Fargeau and Serville,
 17, 22, 25, 28
cylindrica Say, 28, 29
menthrastri Linnaeus, 30
robusta Curran, 28, 29
scripta Fluke, 29
 spiracles, 21
strigatus Fallén, *Eumerus*, 87
Syrpitta St. Fargeau and Serville, 23, 27,
 89
piptiens Linnaeus, 90
Syrphus Fabricius, 17, 18, 22, 26, 42
knabi Shannon, 43, 47
rectus Osten Sacken, 43, 44
ribesii Linnaeus, 45
ribesii vittafrons Shannon, 43, 45
torvus Osten Sacken, 43, 46
- Temnostoma* St. Fargeau and Serville,
 24, 26, 81
balyras (Walker), 81, 83
bombylans Fabricius, 81
tibialis Fallén, *Paragus*, 71
torvus Osten Sacken, *Syrphus*, 43, 46
- triangulifer* Zetterstedt, *Epistrophe*, 63,
 65
tristis Loew, *Microdon*, 97
Tropidia Meigen, 24, 26, 94
quadrata Say, 94
tuberculatus Rondani, *Eumerus*, 88
- vacua* Osten Sacken, *Brachyopa*, 95
vinelandi (Curran), *Metasyrphus*, 50, 52
Volucella Geoffrey, 23, 27, 96
nigra Greene, 26, 96
volucris Osten Sacken, *Eupeodes*, 41
- weborgi* (Fluke), "*Metasyrphus*," 59
wiedemanni (Johnson), *Metasyrphus*,
 50
- Xanthogramma* Schiner, 18, 57, 76
flavipes Loew, 24, 76
Xylota Meigen, 23, 26, 77
bicolor Loew, 78, 80
fraudulosa Loew, 78
nemorum Fabricius, 78, 79
pigra Fabricius, 78, 79

4

UNIVERSITY OF ILLINOIS BULLETIN

Vol. XXXVI

August 30, 1938

No. 1

A Classification of the Larvae and Puparia of the Syrphidae of Illinois Exclusive of Aquatic Forms

BY

ELIZABETH M. HEISS

Price \$1.50

UNIVERSITY OF ILLINOIS
LIBRARY
5 1938
NATURAL HISTORY LIBRARY

PUBLISHED BY THE UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS

Natural History Library

UNIVERSITY OF ILLINOIS BULLETIN

ISSUED TWICE A WEEK

Entered as second-class matter, Dec. 11, 1912, at the post office at Urbana, Illinois, under the Act of August 24, 1912. Acceptance for mailing at the special rate of postage provided for in section 1103, Act of October 3, 1917, authorized July 31, 1918.

ILLINOIS BIOLOGICAL MONOGRAPHS are published serially, each volume consisting of four numbers. The subscription price is four dollars a volume. Prices of individual numbers are indicated in the list of titles given on the back cover. Requests for exchanges should be addressed to Exchange Department, University of Illinois Library, Urbana, Illinois. All communications concerning sale or subscription should be addressed to the Director, University of Illinois Press, Urbana, Illinois.

ILLINOIS BIOLOGICAL MONOGRAPHS

Vol. I

- Nos. 1-2. A Revision of the Cestode Family Proteocephalidae. With 16 plates. By G. R. La Rue. \$2.00.
No. 3. Studies on the Cestode Family Anoplocephalidae. With 6 plates. By H. Douthitt. 80 cts.
No. 4. Some North American Larval Trematodes. With 8 plates. By W. W. Cort. \$1.20.

Vol. II

- No. 1. Classification of Lepidopterous Larvae. With 10 plates. By S. B. Fracker. \$1.50.
No. 2. On the Osteology of Some of the Loricati. With 5 plates. By J. E. Gutberlit. 50 cts.
No. 3. Studies on Gregarines. With 15 plates. By Minnie E. Watson. \$2.00.
No. 4. The Genus *Meliola* in Porto Rico. With 5 plates. By F. L. Stevens. (Out of print).

Vol. III

- No. 1. Studies on the Factors Controlling the Rate of Regeneration. By C. Zeleny. \$1.25.
No. 2. The Head-capsule and Mouth-parts of Diptera. With 25 plates. By A. Peterson. \$2.00.
No. 3. Studies on North American Polystomidae, Aspidogastridae, and Paramphistomidae. With 11 plates. By H. W. Stunkard. \$1.25.
No. 4. Color and Color-pattern Mechanism of Tiger Beetles. With 29 black and 3 colored plates. By V. E. Shelford. \$2.00.

Vol. IV

- No. 1. Life History Studies on Montana Trematodes. With 9 plates. By E. C. Faust. \$2.00.
No. 2. The Goldfish (*Carassius carassius*) as a Test Animal in the Study of Toxicity. By E. B. Powers. \$1.00.
No. 3. Morphology and Biology of Some Turbellaria from the Mississippi Basin. With 3 plates. By Ruth Higley. \$1.25.
No. 4. North American Pseudophyllidean Cestodes from Fishes. With 13 plates. By A. R. Cooper. \$2.00.

Vol. V

- No. 1. The Skull of *Amiurus*. With 8 plates. By J. E. Kindred. \$1.25.
No. 2. Contributions to the Life Histories of *Gordius robustus* Leidy and *Paragordius varius* (Leidy). With 21 plates. By H. G. May. \$1.50.
Nos. 3-4. Studies on Myxosporidia. A synopsis of Genera and Species of Myxosporidia. With 25 plates and 2 text-figures. By R. Kudo. \$3.00.

Vol. VI

- No. 1. The Nasal Organ in Amphibia. With 10 plates. By G. M. Higgins. \$1.00.
Nos. 2-3. Revision of the North American and West Indian Species of *Cuscuta*. With 13 plates. By T. G. Yuncker. \$2.00.
No. 4. The Larvae of the Coccinellidae. With 6 plates. By J. H. Gage. 75 cts.

Vol. VII

- No. 1. Studies on Gregarines, II. Synopsis of the Polycystid Gregarines. With 4 plates. By Minnie Watson Kamm. \$1.00.
No. 2. The Molluscan Fauna of the Big Vermilion River, Illinois. With 15 plates. By F. C. Baker. \$1.25.
No. 3. North American Monostomes. With 9 plates. By E. C. Harrah. \$1.25.
No. 4. A classification of the Larvae of the Tenthredinoidea. With 14 plates. By H. Yuasa. \$2.00.

Vol. VIII

- No. 1. The Head-capsule of Coleoptera. With 26 plates. By F. S. Stickney. \$2.00.
No. 2. Comparative Studies on Certain Features of Nematodes and Their Significance. With 4 plates. By D. C. Hetherington. \$1.00.
No. 3. Parasitic Fungi from British Guiana and Trinidad. With 19 plates. By F. L. Stevens. \$1.25.
No. 4. The External Morphology and Postembryology of Noctuid Larvae. With 8 plates. By L. B. Ripley. \$1.25.

[Continued on back cover.]

Vol. IX

- No. 1. The Calciferous Glands of Lumbricidae and Diplocardia. With 12 plates. By Frank Smith. \$1.25.
 Nos. 2-3. A Biologic and Taxonomic Study of the Microsporidia. With 27 plates and 9 text-figures. By R. Kudo. \$3.00.
 No. 4. Animal Ecology of an Illinois Elm-maple Forest. With 7 plates. By A. O. Weese. \$1.25.

Vol. X

- No. 1. Studies on the Avian Species of the Cestode Family Hymenolepididae. With 9 plates and 2 text-figures. By R. L. Mayhew. \$1.50.
 No. 2. Some North American Fish Trematodes. With 6 plates, 2 charts, and 1 text-figure. By H. W. Manter. \$1.50.
 No. 3. Comparative Studies on Furcercous Cercarie. With 8 plates and 2 text-figures. By H. M. Miller. \$1.25.
 No. 4. A Comparison of the Animal Communities of Coniferous and Deciduous Forests. With 16 plates. By I. H. Blake. \$1.50.

Vol. XI

- No. 1. An Ecological Study of Southern Wisconsin Fishes. With 16 plates. By A. R. Cahn. \$1.50.
 No. 2. Fungi from Costa Rica and Panama. With 18 plates. By F. L. Stevens. \$1.25.
 No. 3. The Structure and Development of Corallobothrium. With 5 plates. By H. E. Essex. \$1.00.
 No. 4. Studies on the Caryophyllacidae of North America. With 7 plates. By G. W. Hunter, III. \$1.25.

Vol. XII

- No. 1. Morphological Studies of the Genus Cercospora. With 4 plates. By W. G. Solheim. \$1.00.
 No. 2. Morphology, Taxonomy, and Biology of Larval Scarabaeoidea. With 15 plates. By W. P. Hayes. \$1.25.
 No. 3. Sawflies of the Sub-Family Dolerinae of America North of Mexico. With 6 plates. By H. H. Ross. \$1.25.
 No. 4. A Study of Fresh-water Plankton Communities. By Samuel Eddy. \$1.00.

Vol. XIII

- No. 1. Studies on Some Protozoan Parasites of Fishes of Illinois. With 8 plates. By R. R. Kudo. 75 cts.
 No. 2. The Papillose Alloeceadiidae: A Study of Their Morphology, Life Histories, and Relationships. With 4 plates and 6 text-figures. By S. H. Hopkins. \$1.00.
 No. 3. Evolution of Foliar Types, Dwarf Shoots, and Cone Scales of Pinus, with Remarks Concerning Similar Structures in Related Forms. With 32 text-figures. By C. C. Doak. \$1.50.
 No. 4. A Monographic Rearrangement of Lophodermium. With 5 plates. By L. R. Tehon. \$2.00.

Vol. XIV

- No. 1. Development of the Pectoral Limb of *Necturus maculosus*. With 11 plates. By H. K. Chen. \$1.00.
 No. 2. Studies on North American Cercariae. With 8 plates. By E. L. Miller. \$1.50.
 No. 3. Studies on the Morphology and Life History of Nematodes in the Genus Spironoura. With 5 plates and 2 text-figures. By J. G. Mackin. \$1.00.
 No. 4. The Life History of *Cotylophoron cotylophorum*, a Trematode from Ruminants. With 9 plates. By H. J. Bennett. \$1.50.

Vol. XV

- No. 1. Experimental Studies on *Echinostoma revolutum* (Froelich), a Fluke from Birds and Mammals. With 3 plates. By P. C. Beaver. \$1.00.
 No. 2. A Generic Classification of the Nearctic Sawflies. With 17 plates. By H. H. Ross. \$2.00.
 No. 3. Studies on the Biology of the Crayfish *Cambarus propinquus* Girard. With 46 graphs. By W. C. Van Deventer. \$1.00.
 No. 4. Taxonomic Studies on the Mouth Parts of Larval Anura. With 3 figures and 8 charts. By J. R. Nichols. \$1.00.

Vol. XVI

- Nos. 1-2. The Turtles of Illinois. With 31 plates, 20 maps, and 15 text-figures. By A. R. Cahn. \$3.00.
 No. 3. The Phylogeny of the Hemiptera, Based on a Study of the Head Capsule. With 24 plates. By C. S. Spooner. \$1.00.

Address orders: Director, University of Illinois Press, Urbana, Illinois.

UNIVERSITY OF ILLINOIS-URBANA

570.5ILL

C001

ILLINOIS BIOLOGICAL MONOGRAPHS\$URBANA

16 1937-38



3 0112 009416469